WZI INC.

Analysis of Formation Water Chemistry
Cat Canyon Oil Field

Santa Barbara County, California

August 2017

Prepared by:
WZI Inc.
1717 28th Street
Bakersfield, CA 93301

Table of Contents

Figures

Tables

Appendices

1 Executive Overview

1.1 Area of Review

The Sisquoc Sands and Monterey Formation in the Cat Canyon Oil Field are hydrocarbon bearing and producing with the assistance of steam injection and water flood for enhanced recovery and water re-injection. Water re-injection and gas re-injection into the exempted areas are currently utilized as part of the current Maximum Efficient Rate (MER). **Figure 1.1-1, Proposed Aquifer Exemption Study Area**, shows the location of Proposed Aquifer Exemption Expansion Areas in the Cat Canyon Oil Field. Historic exemption status was not consistent with the producing areas at the time of the original delegation by US Environmental Protection Agency (EPA).

The Treatability Feasibility Study will present three cases from this Analysis of Formation Chemistry: high, medium and low. The Low Case being a conservative case in which low TDS and low boron are considered as if ideal conditions could result in sufficient production of previously injected steam (now condensate) to meet the minimum production hurdle, **Appendix 6-I, Treatment Feasibility Study in the Aquifer Exemption Expansion Study**.

1.2 Summary of Results

Table 1.2-1, Summary of Historic Exemption and Proposed Expansion by Area shows the historic status and the proposed exemptions by five (5) Areas within Cat Canyon Oil Field (Central, West, East, Sisquoc and Gato Ridge). The producing areas and the exemption study area are shown on **Figure 1.2-1, DOGGR Producing Area Map (1973).**

The Monterey Formation and the Sisquoc Sands produce oil within the Cat Canyon Oil Field. The formations contain water with average Total Dissolved Solids (TDS) ranging from 7,668 mg/L (East Area Sisquoc Sands) to 19,821 mg/L (Sisquoc Area, Sisquoc Sands) as shown in **Table 1.2-2, Summary of Reviewed Data by Area and Formation.**

Re-injected water in the Cat Canyon Oil Field includes steam injection (into the Sisquoc Sands), water flood and some disposal. Produced water re-injection is considered a critical production activity necessary for enhanced oil recovery. Produced gas which cannot be used or sold is re-injected with the produced water in some instances where appropriate.

Table 1.2-1: Summary of Historic Exemption and Proposed Expansion by Area				
Current Exemption		**Proposed Expansion**		**Description of Expansion**
Formation	**Interval/Sand**	**Formation**	**Interval/Sand**	
Central Area:				
Sisquoc	Sisquoc	Sisquoc	Sisquoc	Expand Area
		Monterey	Monterey	Add Monterey
East Area:				
Sisquoc	Sisquoc	Sisquoc	Sisquoc	Expand Area and consolidate Brooks
Sisquoc	Brooks			
Monterey	Monterey	Monterey	Monterey	Expand Area
West Area:				
Sisquoc	S1b	Sisquoc	Sisquoc	Expand Area and include all Sisquoc Sands
Sisquoc	Los Flores (S9-S10)			
Monterey	Cherty Zone	Monterey	Monterey	Expand Area and include all Monterey formation
Sisquoc Area:				
Sisquoc	Sisquoc	Sisquoc	Sisquoc	Expand Area, consolidate Thomas and add Brooks
Sisquoc	Thomas			
Monterey	Monterey	Monterey	Monterey	Expand Area
Gato Ridge:				
Sisquoc	Sisquoc	Sisquoc	Sisquoc	Expand Area
Monterey	Buff and Brown	Monterey	Monterey	Expand Area and include all Monterey formation

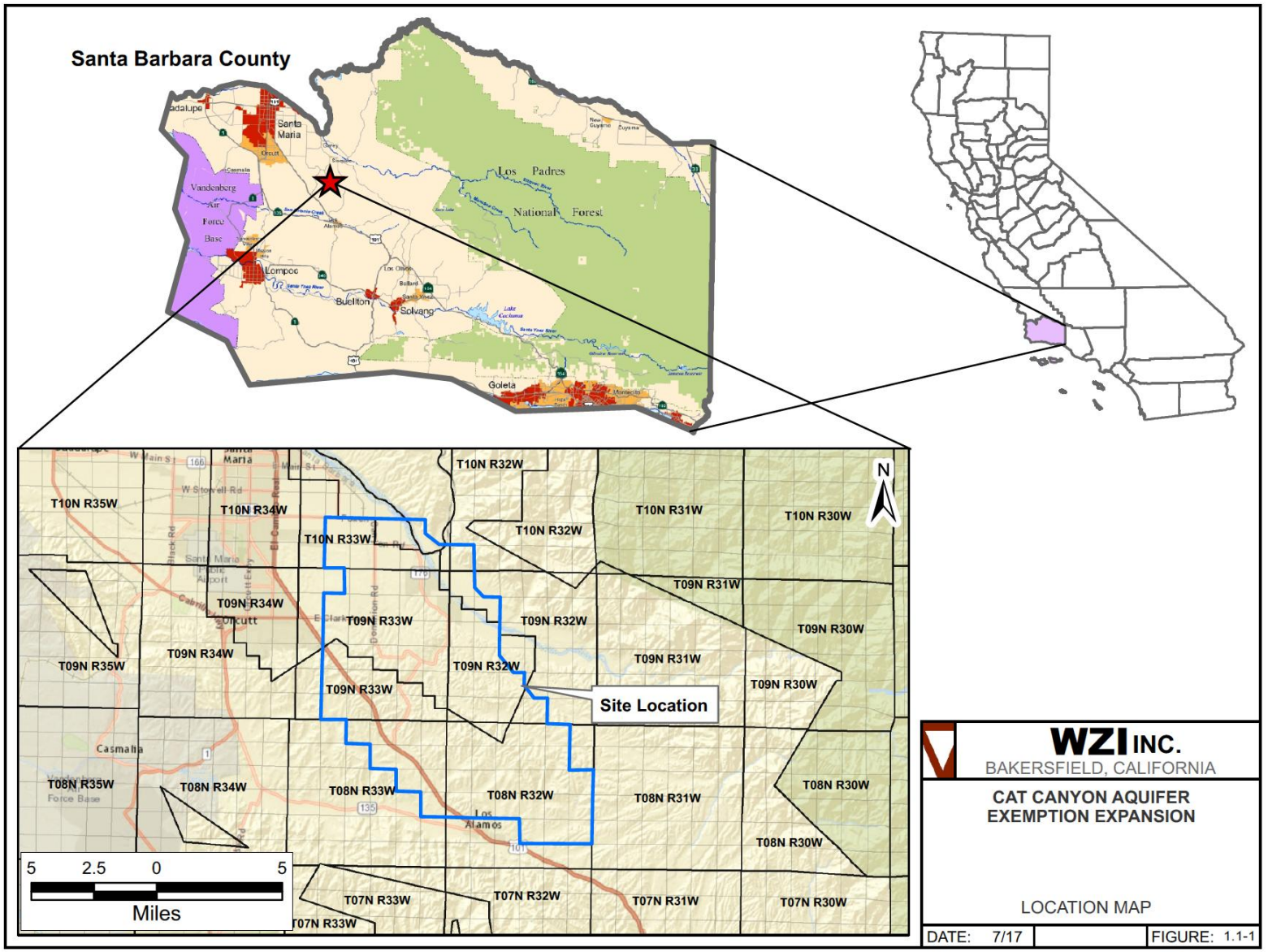
Santa Barbara County
Santa Maria
Vandenberg Air Force Base
Lompoc
Buellton
Solvang
Los Padres National Forest
Goleta
T10N R35W
T10N R34W
T10N R33W
T10N R32W
T10N R31W
T10N R30W
T09N R35W
T09N R34W
T09N R33W
T09N R32W
T09N R31W
T09N R30W
T08N R35W
T08N R34W
T08N R33W
T08N R32W
T08N R31W
T08N R30W
T07N R33W
T07N R32W
T07N R31W
T07N R30W
Site Location
N
5 2.5 0 5
Miles
WZI INC.
BAKERSFIELD, CALIFORNIA
CAT CANYON AQUIFER EXEMPTION EXPANSION
LOCATION MAP
DATE: 7/17
FIGURE: 1.1-1

Figure 1.2

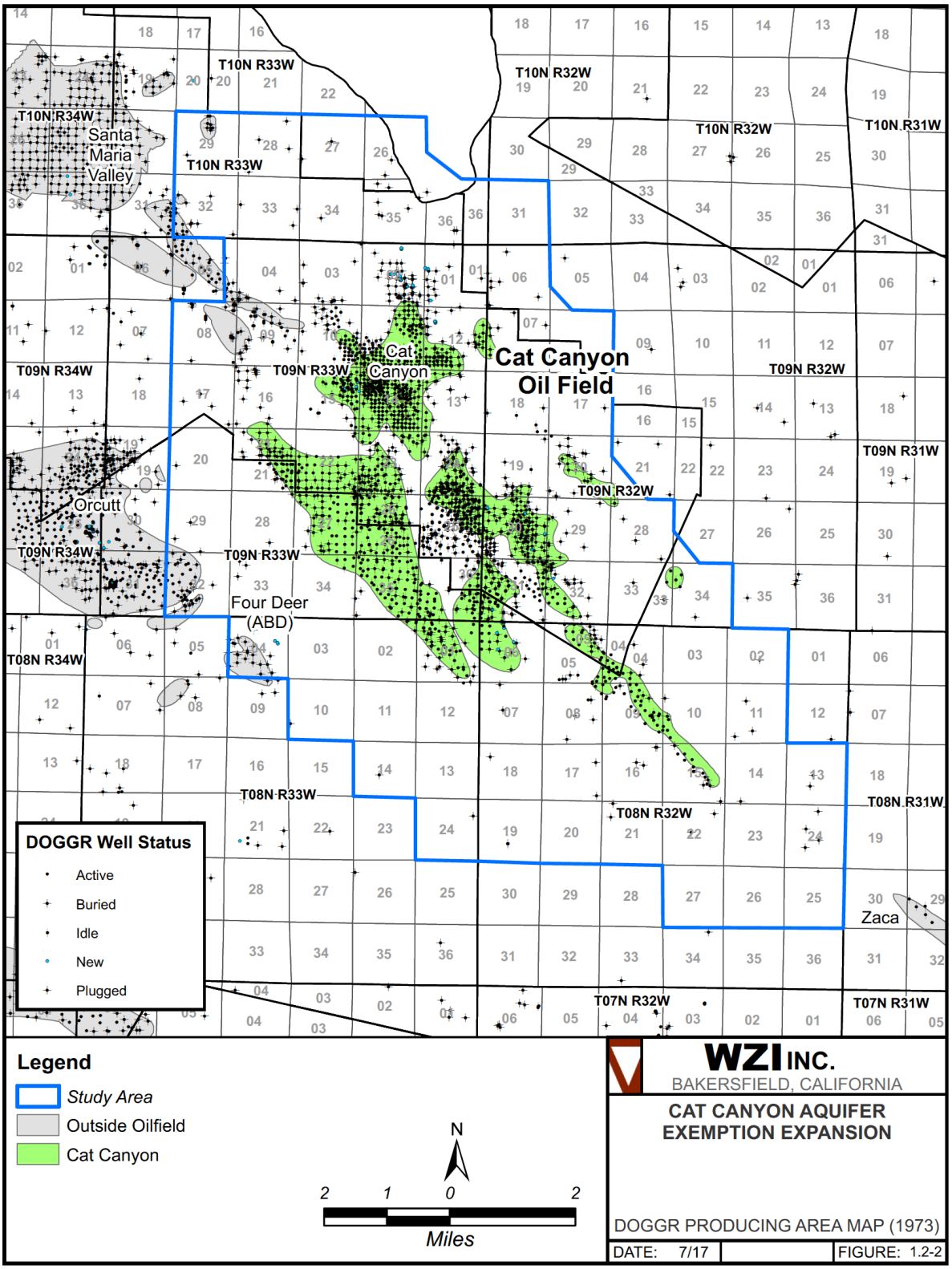
Cat Canyon Oil Field
Cat Canyon
Santa Maria Valley
Orcutt
Four Deer (ABD)
Zaca
T10N R33W
T10N R32W
T10N R31W
T10N R34W
T09N R34W
T09N R33W
T09N R32W
T09N R31W
T08N R34W
T08N R33W
T08N R32W
T08N R31W
T07N R32W
T07N R31W
DOGGR Well Status
Active
Buried
Idle
New
Plugged
Legend
Study Area
Outside Oilfield
Cat Canyon
N
2 1 0 2
Miles
WZI INC.
BAKERSFIELD, CALIFORNIA
CAT CANYON AQUIFER EXEMPTION EXPANSION
DOGGR PRODUCING AREA MAP (1973)
DATE: 7/17
FIGURE: 1.2-2

Figure 1.2-2

Table 1.2-2: Summary of Reviewed Data by Area and Formation(mg/L)

Area	Formation		TDS	B	Na	CL	SO4	HCO3	Ca	K	Mg
Sisquoc	Average Sisquoc	Mean	9990	26	1151	3266	116	4680	110	47	214
		Std Dev.	8028	9	721	2812	218	5196	51	59	177
		Count	38	28	28	36	27	29	9	27	27
	Post Steaming Production	Mean	5862	26	961	1924	75	2209	104	41	247
		Std Dev.	2600	9	426	1200	46	1572	50	60	179
		Count	27	25	22	27	22	22	8	22	21
	Native Sisquoc Formation	Mean	19862	34	2311	7436	295	11004	113	71	91
		Std Dev.	7558	17	1612	2269	500	6143	67	46	113
		Count	12	4	7	10	5	8	2	6	7
	Monterey	Mean	10417	7	1153	3216	57	4657	82	26	98
		Std Dev.	6445	5	798	1828	51	2395	73	23	82
		Count	14	14	14	14	14	14	6	14	12
Central	Sisquoc	Mean	10745	28	1641	4001	47	5539	29	36	21
		Std Dev.	3815	20	801	1420	22	2496	8	24	17
		Count	14	11	11	11	11	11	4	11	8
	Monterey	Mean	12314	19	1188	4033	67	5109	44	41	56
		Std Dev.	6823	22	454	1958	87	2221	7	68	37
		Count	17	7	16	16	17	17	5	16	15
East	Monterey	Mean	10417	7	1153	3216	57	4657	82	26	98
		Std Dev.	6445	5	798	1828	51	2395	73	23	82
		Count	14	14	14	14	14	14	6	14	12
	Sisquoc	Mean	7668	12	1263	2740	27	3528	41	16	75
		Std Dev.	2547	12	768	1019	20	1806	12	11	51
		Count	17	9	14	14	14	14	2	13	13
West	Monterey	Mean	12314	19	1188	4033	67	5109	44	41	56
		Std Dev.	6823	22	454	1958	87	2221	7	68	37
		Count	17	7	16	16	17	17	5	16	15
	Sisquoc	Mean	22007	42	876	8063	147	12252	15	50	49
		Std Dev.	5280	29	442	2096	103	3700		28	94
		Count	9	5	8	8	8	8	1	8	5
Gato Ridge	Monterey	Mean	9118	29	1769	3207	29	4003	41	14	62
		Std Dev.	1151	14	528	367	11	698	11	10	74
		Count	55	40	42	51	52	42	5	40	34
	Sisquoc	Mean	21000								
		Std Dev.									
		Count	1								
	Sisquoc/ Monterey	Mean	6333								
		Std Dev.	153								
		Count	3								

1.3 Cyclic Steam Issues in Sisquoc Sands

There is strong evidence supporting the conclusion that a statistical bias is present in the formation water quality data due to sampling cyclic steam condensate. Condensate dilutes whatever actual connate formation water is released during post steam injection oil production.

Cyclic production will return the steam (as condensate) or injected water as part of the enhanced oil recovery process. The production fluid returns have higher water cuts than the native formation would provide. In the course of the life of the EOR project, once the production from a particular well becomes uneconomic, no more steam will be injected; the well may be re-tasked, idled or abandoned.

Any sampling efforts on cyclic steamed wells to determine the actual formation connate water should only take place immediately before the next scheduled cycle of steam injection and even then the samples may be confounded by previous injection of fresher water as steam. The increased number of cycles leaves condensate in the pore space near the well bore and the nearby portion of the capture radius.

Mass balance indicates that all steam is not recovered. The altered porosity, hydraulic conductivity, storasivity and voidage created by the cyclic removal of hydrocarbons will facilitate capture of the enhanced recovery fluids (particularly water), in the affected zone around a given cyclic well. Storasivity increases as oil is removed from the capture radius of the individual well. If all condensate were able to be produced from a well's capture area, the water composition would approach formation conditions (with commensurate sharp decline in produced water) and a simple plot of the Total Dissolved Solids, (TDS), vs. volume of water pumped and water cut will show an asymptotic approach to the connate formation TDS composition. A native connate water sample for the Sisquoc sands is difficult to collect due to the water producing nature of the actual Sisquoc Sands beyond the specific injection wells' zone of influence (i.e., without steam influence). A more detailed discussion of the Sisquoc formation water sampling is included in the Sisquoc Area discussion in **Section 2.5, Final Results**.

1.4 Cautionary Note

For the purpose of the Aquifer Exemption determination, the data indicate that the East Area Sisquoc Sands are still subject to the review for exemption status since the TDS average is below 10,000 mg/L and there is no adequate historic sampling or other documentation to justify adjustment at the time of this report. However, it is important to caution against any regulatory based determination that might create a false expectation that the Sisquoc Sands (as a whole) contains adequate supplies of low TDS water accessible at the actual formation conditions (under which water may be produced for drinking purposes). The Aquifer Exemption Expansion Application Study addresses the hydrogeology and the Treatment Feasibility Study addresses the sensitivity of the economics in the context of actual formation conditions and drawdown capability of the actual formation.

1.5 Method Notes

1.5.1 Assessing TDS veracity and corrections of Borate to Boron

The preferential order for assessing reliability of methodology for Total Dissolved Solids (TDS) is Gravimetric Method, followed by Lab Summation, followed by summation of report (HCOx0.67), EC based (conversion factor= 0.73). Some of the deviation within general formation data is due to the variation between TDS reporting methods. Instances of unusually high boron values are interpreted to be improperly recorded borate values (borates are approximately 4 times heavier than boron). For analysis in this report, the unusually high borate values were corrected to boron where possible.

1.5.2 No Mass Weighting Assigned to Samples

All samples were assumed to carry equal weighting on a mass basis.

1.5.3 Assignment of sample to Well Numbers

As the review process proceeded though the rejection cycle all API numbers were assigned to wells (where possible) and all area designations were verified. Completions were checked for identified wells where no completion data was provided.

1.5.4 Focused Constituents

While other constituents are available for consideration, primary focus is given to TDS and boron due to their singular relevance to regulatory criteria related to exemption at either the federal or state level or agricultural interest. High Sulfate also presents a problem primarily for infants drinking formula. Other constituents are considered in determining whether a sample is from well control fluids or post steam injection returns.

2 Data Review

2.1 Rejection Pass 0: Review of All Raw Data

The focus of this analysis is to determine the formation water quality. No effort is made to assess impacts of the specific oil field operational practices other than to reject data not representative of the formation's water composition or to explain its use. There are several expected bias sources on which this statistical study will be focused: multiple isolated sands, steam injection, water floods, produced water reinjection, well control fluids, and faults. No steaming was found taking place in the Monterey formation, therefore no dilution of returning produced water is anticipated. Combined injection samples such as tank samples (due to the question of origin) will be rejected however, samples properly gathered to determine receiving formation composition for wells designated as WD pursuant to UIC PALs are utilized. Operationally, returned (post steam injection) water from cyclic steamed,(SC), wells in production phase is diluted with fresher make-up water prior to return as injection at other SC wells in the injection phase.

Appendix I, Original Data Table with All Starting Data, contains all data submitted in support of the analysis. Some records were removed from this data set and others were added as new information was made available during the development of this study. All support documentation can be found in **Appendix III, All Lab Sheets and Support Information**. There were originally 208 records of which 11 were from samples from adjacent oil fields (Santa Maria Valley Oil Field and Zaca Oil Field), **Appendix III**. These were immediately impounded from the Cat Canyon Oil Field Data for the purpose of defining the formation water quality in the specific producing areas of Cat Canyon Oil Field Aquifer Exemption Expansion Area. These impounded records were retained for analysis of the northern extent of the Cat Canyon Aquifer Exemption Expansion Study Area which does intrude in to the Santa Maria Oil Field, See **Table 2.1-1, Non-Cat Canyon Data**. All duplicates were reviewed and once any contrary comments were resolved the duplicate samples were removed.

Table 2.1-1 Non-Cat Canyon Data									
Area	Lease	Well Name/Description	Date	API Number	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
SMV Nicholson	Nicholson	Nicholson waste water	7/17/1972			Monterey		34500	13.99124
SMV Golco	Golco	Golco waste water	7/17/1972			Monterey		33765	13.99124
SMV Lakeview	Lakeview	Lakeview waste water	1/12/1982			Monterey		30707	
SMV Bradley	Bradley Consolidated	Bradley Consolidated 1-37	9/5/1984	8320545	Well	Sisquoc	Basal Sisquoc	28678	97.93868
SMV Main	Hopkins	Hopkins Lease Injection water	5/27/1976			Sisquoc	Basal Sisquoc	24672	10.66132
SMV Clark	Edmonston	Edmonston waste water	7/17/1972			Monterey		24625	27.98248
SMV Clark	Lakeview	Lakeview waste water	7/17/1972			Monterey		23370	20.98686
SMV Bradley	Bradley	RR Bradley 1 Inj	7/15/1988	8320441	Well	Monterey		13700	5.596496
SMV Bradley	Bradley	RR Bradley 1 Prod	8/30/1972	8320441		Monterey		12547	6.99562
SMV Bradley	Bradley	BRADLEY #2		8300301		Monterey		12400	0
ZACA Oil Field	Chamberlin (Zaca)	Chamberlin 1-2	2/10/2012	8322624		Monterey		8530	9.514043

The data set is relatively robust for all producing areas even when incomplete records are rejected; **Figure 2.1-1, Pass 0, All Areas**. There are fewer boron values than TDS values. Prior to analysis, each data for formation were separated in the Data Review (Pass 1, 2 and 3) by Area and Formation. Any incomplete data are noted by "??" and are reviewed during subsequent passes for completion of the missing information. If during the course of the study, data for a rejected record were found to complete the information, it is returned to the surviving cohort. **Table 2.1-2, Summary of All Data by Area (mg/L)**, summarizes all of the original Cat Canyon Oil Field data by area without any rejection other than removal of duplicates and SMV records. Note that even the unknown area records have a high TDS (8,223 mg/L) and high boron (36 mg/L), indicating that if all records with undefined area "??" were rejected they would not have materially lowered the Low Case design water composition value (5,707, mg/L) used in the Treatment Feasibility Study.

Figure 2.1-2, shows the coherently distributed data clusters (highlighted by black lines) are revealed in the probability plots for the data. These clusters may be associated with different areas, formations or consistent sample bias.

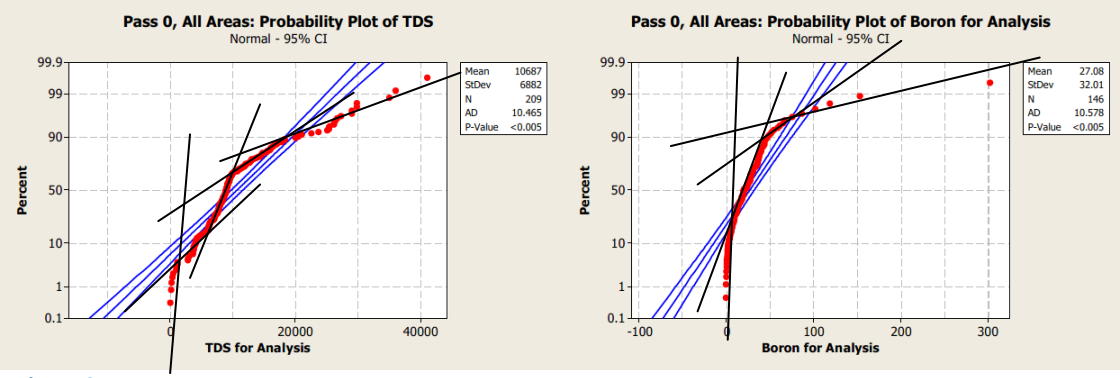

Figure 2.1-1

Figure 2.1-2, shows the probability plot of the data when broken out by area and formation. These data are examined in detail by area and formation in subsequent passes.

Table 2.1-2: Summary of All Data by Area (mg/L)									
		TDS	B	HCO3	Na	Ca	CL	Mg	SO4
??	Mean	8,223.50	36.00	1,640.00	2,607.00	53.50	3,950.00	20.00	16.00
	Standard Deviation	956.72	-	226.27	151.32	3.54	353.55	14.14	-
	Count	2	1	2	2	2	2	2	1
Central	Mean	9,936.50	26.48	1,662.54	3,875.68	47.55	5,385.84	35.81	20.06
	Standard Deviation	4,458.61	20.25	767.49	1,421.56	21.17	2,438.74	23.36	15.81
	Count	16	13	12	12	12	12	12	9
East	Mean	8,292.14	9.41	1,178.49	2,740.89	46.81	3,725.46	20.88	97.17
	Standard Deviation	6,742.91	11.76	1,014.10	2,246.66	39.10	3,120.41	17.51	80.44
	Count	43	33	40	40	40	40	40	40
Gato Ridge	Mean	9,357.46	29.57	1,716.93	3,319.47	29.48	3,875.34	14.58	61.08
	Standard Deviation	3,720.71	19.45	528.44	851.66	11.62	871.43	9.58	70.23
	Count	70	47	48	60	62	50	47	40
Olivera	Mean	16,782.50	-	2,290.00	5,967.50	91.50	7,890.00	61.50	447.50
	Standard Deviation	15,031.31	-	2,205.48	5,580.09	27.14	7,286.16	19.05	37.53
	Count	4	-	4	4	4	4	4	4
Sisquoc	Mean	11,081.61	29.86	1,144.85	3,512.94	132.36	5,224.63	61.12	191.96
	Standard Deviation	8,767.66	18.03	602.97	2,783.89	225.86	5,068.45	94.09	175.25
	Count	42	32	37	39	37	39	37	36
West	Mean	15,770.76	45.85	1,408.99	5,423.60	82.12	7,367.54	38.24	76.79
	Standard Deviation	6,932.11	70.26	823.98	2,432.25	87.59	3,805.37	50.44	77.39
	Count	34	20	32	32	33	33	32	28

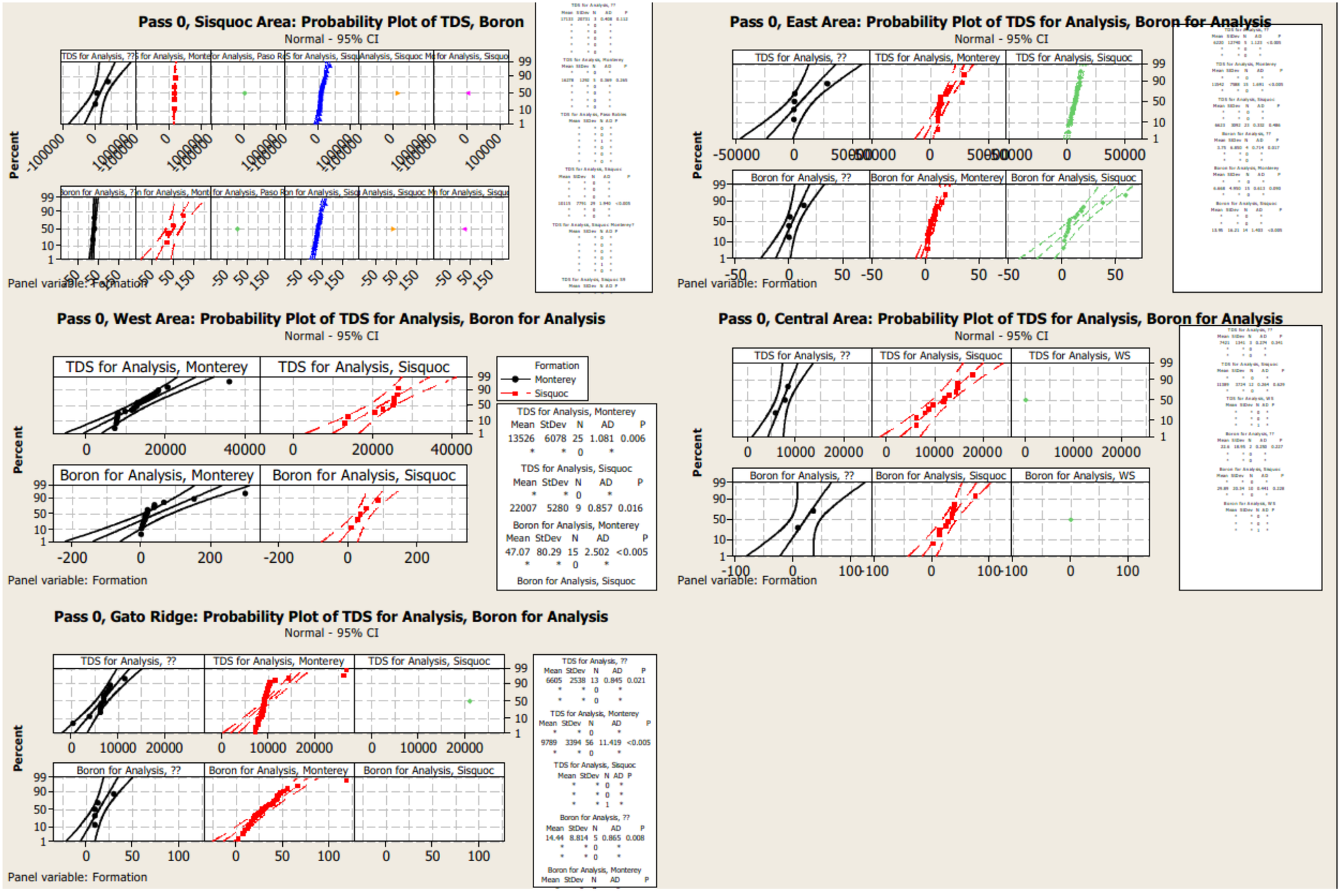
Pass 0, Sisquoc Area: Probability Plot of TDS, Boron
Normal - 95% CI
Panel variable: Formation
Pass 0, East Area: Probability Plot of TDS for Analysis, Boron for Analysis
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, ??
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Panel variable: Formation
Pass 0, West Area: Probability Plot of TDS for Analysis, Boron for Analysis
Normal - 95% CI
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Formation
Monterey
Sisquoc
TDS for Analysis, Monterey
Mean StDev N AD P
13526 6078 25 1.081 0.006
TDS for Analysis, Sisquoc
Mean StDev N AD P
22007 5280 9 0.857 0.016
Boron for Analysis, Monterey
Mean StDev N AD P
47.07 80.29 15 2.502 <0.005
Boron for Analysis, Sisquoc
Panel variable: Formation
Pass 0, Central Area: Probability Plot of TDS for Analysis, Boron for Analysis
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Sisquoc
TDS for Analysis, WS
Boron for Analysis, ??
Boron for Analysis, Sisquoc
Boron for Analysis, WS
Panel variable: Formation
Pass 0, Gato Ridge: Probability Plot of TDS for Analysis, Boron for Analysis
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, ??
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
TDS for Analysis, ??
Mean StDev N AD P
6605 2538 13 0.845 0.021
TDS for Analysis, Monterey
Mean StDev N AD P
9789 3394 56 11.419 <0.005
TDS for Analysis, Sisquoc
Mean StDev N AD P
Boron for Analysis, ??
Mean StDev N AD P
14.44 8.814 5 0.865 0.008
Boron for Analysis, Monterey
Mean StDev N AD P
Panel variable: Formation

Figure 2.1-2

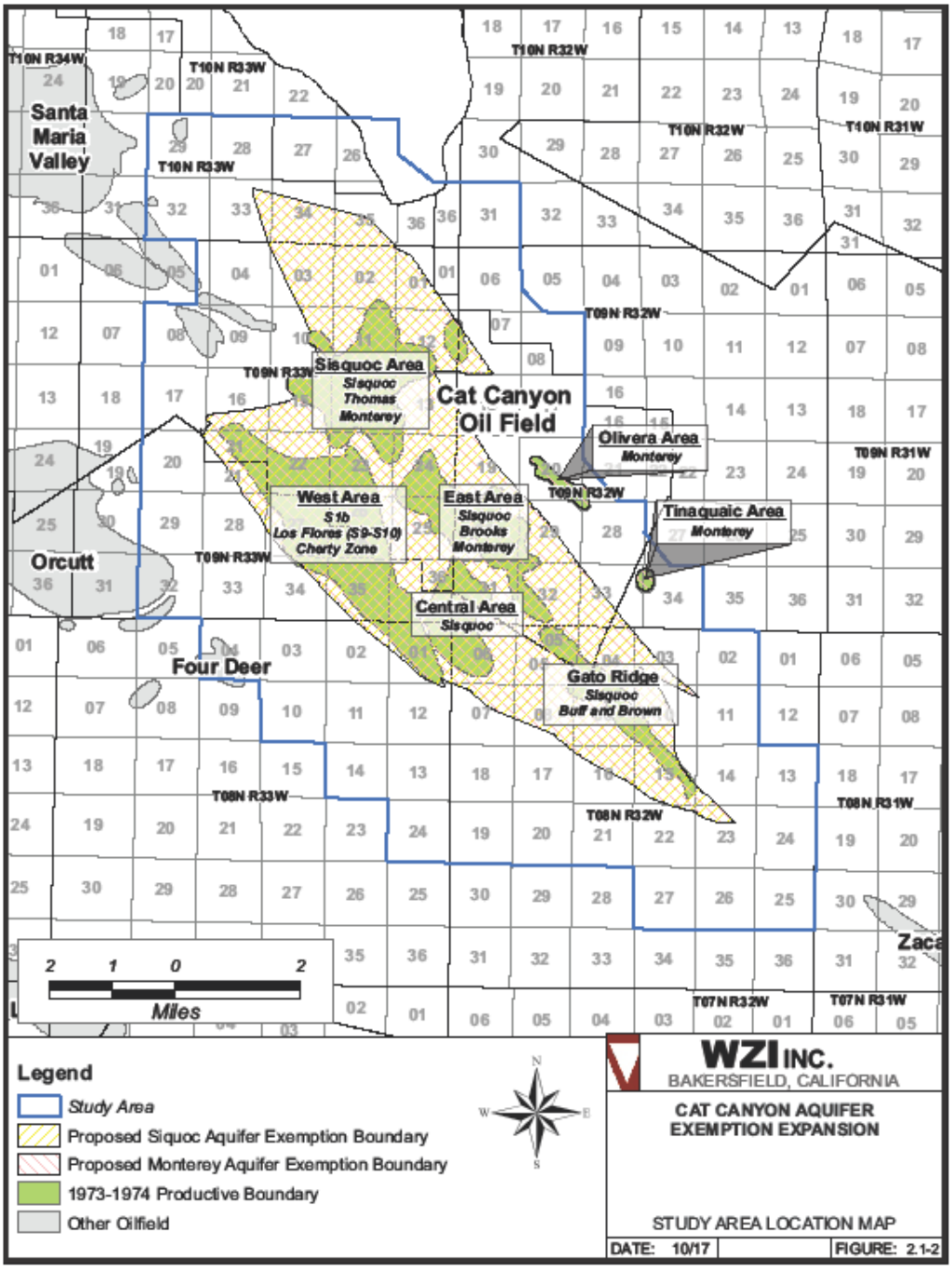
Santa Maria Valley
Orcutt
Four Deer
Sisquoc Area
Sisquoc
Thomas
Monterey
Cat Canyon Oil Field
West Area
S1b
Los Flores (S9-S10)
Cherty Zone
East Area
Sisquoc
Brooks
Monterey
Central Area
Sisquoc
Olivera Area
Monterey
Tinaquaic Area
Monterey
Gato Ridge
Sisquoc
Buff and Brown
T10N R34W
T10N R33W
T10N R32W
T10N R31W
T09N R33W
T09N R32W
T09N R31W
T08N R33W
T08N R32W
T08N R31W
T07N R32W
T07N R31W
2 1 0 2
Miles
Legend
Study Area
Proposed Siquoc Aquifer Exemption Boundary
Proposed Monterey Aquifer Exemption Boundary
1973-1974 Productive Boundary
Other Oilfield
N
W
E
S
WZI INC.
BAKERSFIELD, CALIFORNIA
CAT CANYON AQUIFER EXEMPTION EXPANSION
STUDY AREA LOCATION MAP
DATE: 10/17
FIGURE: 2.1-2

Figure 2.1-2

All Cat Canyon Oil Field Areas show consistent TDS higher than 3000 mg/L and values for boron higher than 6 mg/L in the Sisquoc Sands and Monterey Formation. The West Area has the highest area-wide average TDS and the East Area has the lowest. Sodium and Chloride ratios appear to be consistent. Sulfates appear to be consistently high (16 mg/L to 447mg/L). Analysis of the boron in the context of steaming may indicate that the boron concentration is biased high possible due to the solubility of the salts of boron (tincal, borax, pyroboric acid, etc.) in steam and hot condensate from injection into in the Sisquoc Sands, (Hawley, 1981).

2.2 Non-Cat Canyon Samples (Santa Maria Valley Oil Field)

Some of the data in the original files do not belong to wells in the actual Aquifer Exemption Expansion Area. However, the extension of the study area does encompass some of the nearby Santa Maria Valley Oil Field, **Figure 1.1-1**. These data help define the trend towards the north of the subject study area. These data are plotted along with the other final results on **Figure 2.5-1**; the chart show that the TDS increases as the production moves to the northern reaches of the subject study area. **Figure 2.2-1, Probability Plot of TDS for Analysis, Boron for Analysis**, shows the probability plot for the SMV samples. The trend toward the SMVOF area is toward higher [TDS] for both Monterey Formation ([TDS] =23,202 mg/L) and Sisquoc Sands ([TDS] = 26,675 mg/L).

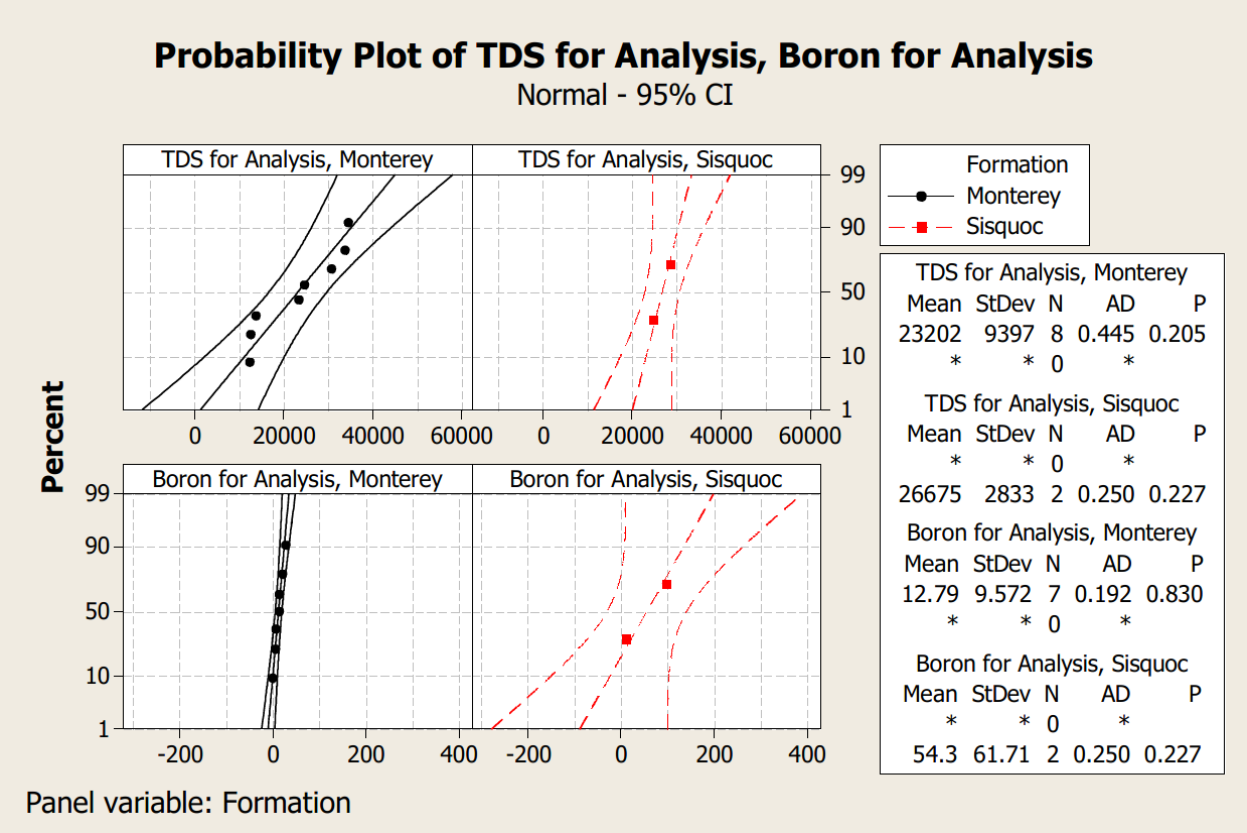

Figure 2.2-1

2.3 First Pass - Low Value Rejection

The first pass rejection focused on eliminating non-formation sources of bias particularly from samples representing upper groundwater (freshwater). These samples were examined and rejected primarily on Total Dissolved Solids by producing area and any wells with DOGGR well type designation "WS" were carefully reviewed for completion. Every consideration is given to keeping samples with lower [TDS] and [B] even if non-assigned. This is a conservative approach to force a low design [TDS] for use in the Aquifer Exemption and the Treatment Feasibility Study.

The low [TDS] samples that were clearly not marked or otherwise identified as freshwater samples were reviewed for evidence of formation dilution from groundwater sources infiltrating production well samples, (i.e. samples from wells with casing leaks may lead to "watering in" of deeper formation samples from in-rushing shallower groundwater during sampling of the deeper formation (whose formation pressure is lower than the static head of the column formed by any groundwater in the casing). No evidence of this was found, leaving the question of condensate as the most likely explanation for low [TDS] in samples from the oil producing formations. **Figure 2.3-1, Probability Plots with Area and Formation Breakdown**, shows the probability plot of the data with a breakdown by area and formation. These are examined individually in detail by area.

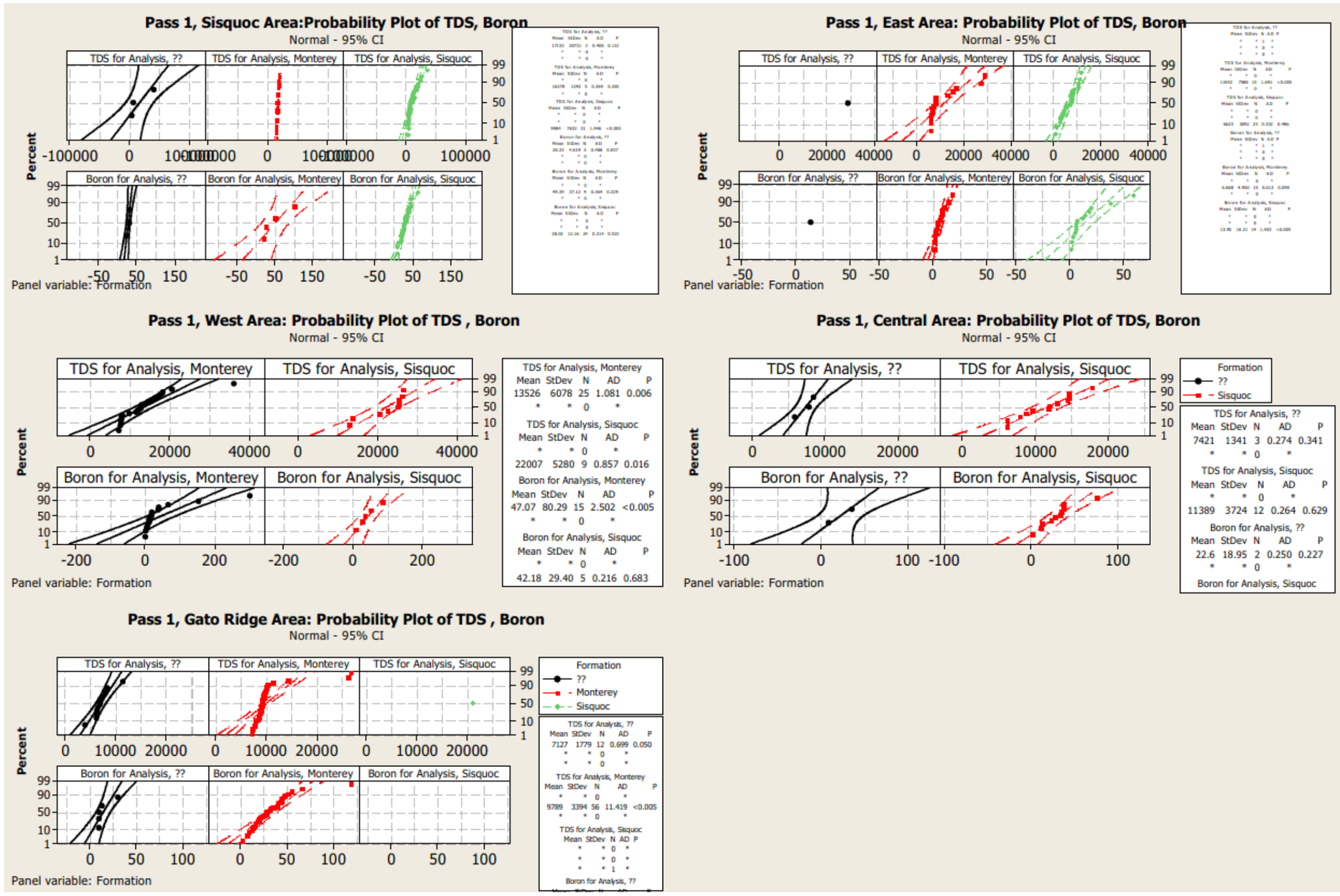
Pass 1, Sisquoc Area:Probability Plot of TDS, Boron
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, ??
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation
Pass 1, East Area: Probability Plot of TDS, Boron
Normal - 95% CI
Pass 1, West Area: Probability Plot of TDS , Boron
Normal - 95% CI
TDS for Analysis, Monterey 13526 6078 25 1.081 0.006
TDS for Analysis, Sisquoc 22007 5280 9 0.857 0.016
Boron for Analysis, Monterey 47.07 80.29 15 2.502 <0.005
Boron for Analysis, Sisquoc 42.18 29.40 5 0.216 0.683
Pass 1, Central Area: Probability Plot of TDS, Boron
Normal - 95% CI
Formation
??
Sisquoc
TDS for Analysis, ?? 7421 1341 3 0.274 0.341
TDS for Analysis, Sisquoc 11389 3724 12 0.264 0.629
Boron for Analysis, ?? 22.6 18.95 2 0.250 0.227
Boron for Analysis, Sisquoc
Pass 1, Gato Ridge Area: Probability Plot of TDS , Boron
Normal - 95% CI
Formation
??
Monterey
Sisquoc
TDS for Analysis, ?? 7127 1779 12 0.699 0.050
TDS for Analysis, Monterey 9789 3394 56 11.419 <0.005
TDS for Analysis, Sisquoc
Boron for Analysis, ??

Figure 2.3-1

2.3.1 Sisquoc Area

The Sisquoc Area data reveals a heavy skew indicating that the Monterey and Sisquoc formations are distinctly different, **Figure 2.3-2, Sisquoc Area: Probability Plot of TDS, Boron**. The Monterey formation shows little skew when assessed independently whereas the Sisquoc shows a strong skew even when the two high outliers (with no formation assignment) are rejected. One low TDS sample, a water well, producing from Paso Robles formation (980mg/L), was rejected. The cluster of wells below 6400 mg/L are largely identified as “after steam” producing wells associated with the Sisquoc indicating the dilution effect of the actual formation water due to steam (blue line). This was subjected to more detailed analysis. There are 12 unassigned values, having no API number or formation information, these were not rejected but were considered until proper assignment to a formation was possible or rejection criteria are met.

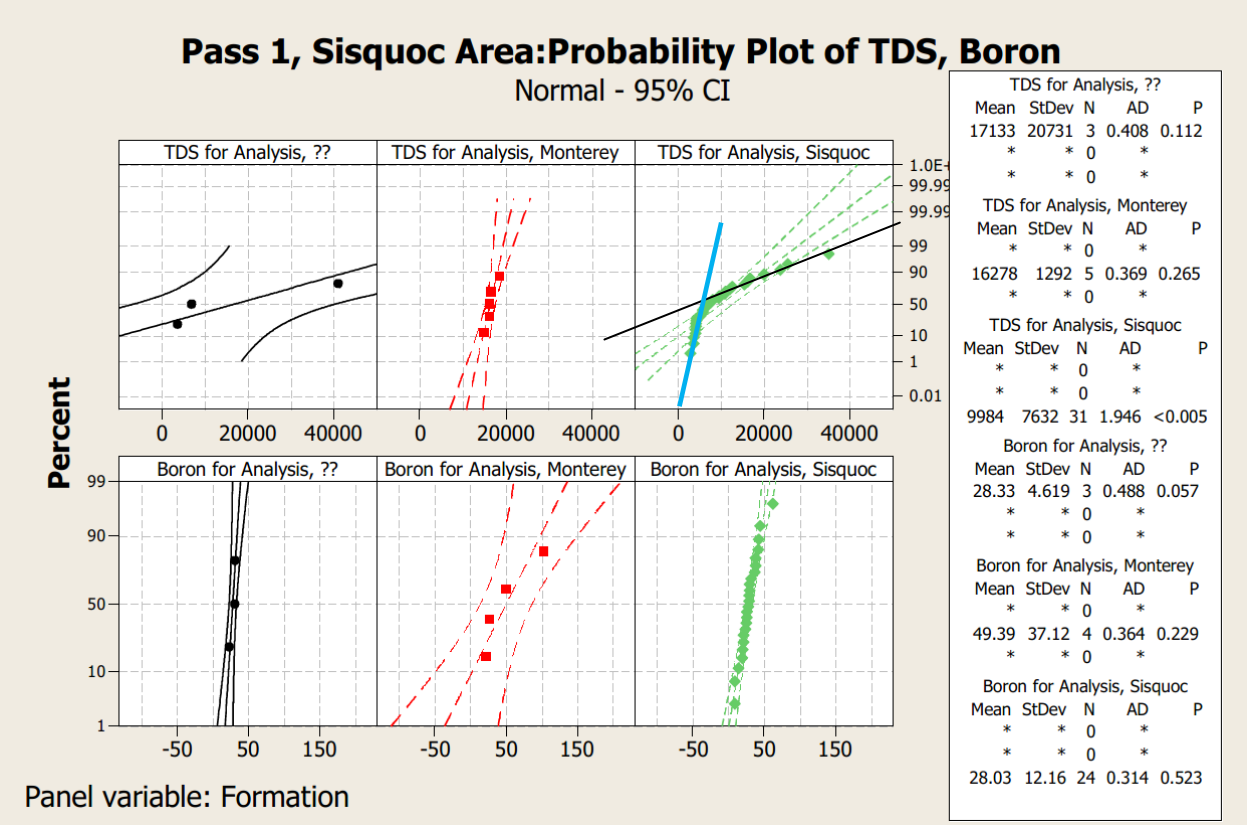

Figure 2.3-2

2.3.2 East Area

Figure 2.3-3, Pass1: East Area Probability Plot of TDS, Boron, shows the probability plots of the first pass analysis of the East Area. There is a cluster of low TDS values identified in the data set (two of which are identified as originating from fresh water wells). These wells serve the producing area in Cat Canyon Oil Field for use in steam injection operations: Brook Oil Co. (1183 mg/L), Bonetti #1 (499 mg/L), Recruit Fee FW5-25 (240 mg/L) and Recruit Fee FW6-25 (180 mg/L). These are rejected as being "Fresh Water", not representative of the formation water. Eight values were not assigned to a formation; these were carried forward for further consideration. There were a cluster of well values near a TDS of 6000 mg/L that may be samples confounded by the dilution effect of steam or may be separated from the remainder of the formation in the East Area by a sealing fault; these values were carried forward in this pass. Two values (no well names) have formation descriptions that appear to be mislabeled; these two samples were not rejected and were addressed in later passes. There are two distinct compositional breaks in the distribution: Monterey TDS and Sisquoc boron. These may be due to faults or completions and in the case of boron, solubility of "borates" in a steaming environment.

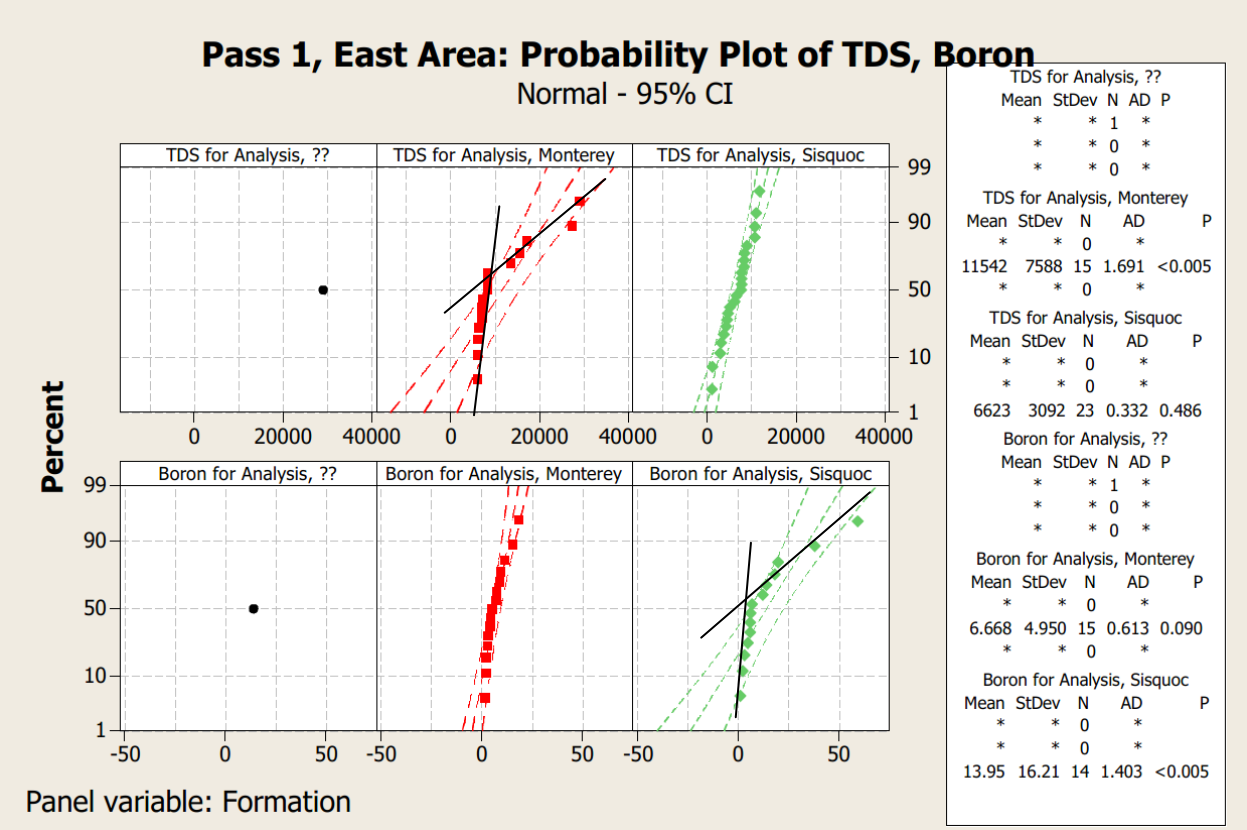

Figure 2.3-3

2.3.3 West Area

Figure 2.3-4, Pass1: West Area Probability Plot of TDS, Boron, shows the probability plots of the first pass analysis of the West Area. In the West Area there were no clusters below 3000 mg/L (a value below which a sample is considered to be from brackish drinking water sources). The data in the Monterey Formation and the Sisquoc Sands break into two distinct compositional elements (black lines); however the analysis investigated these clusters after the second pass rejecting high outliers.

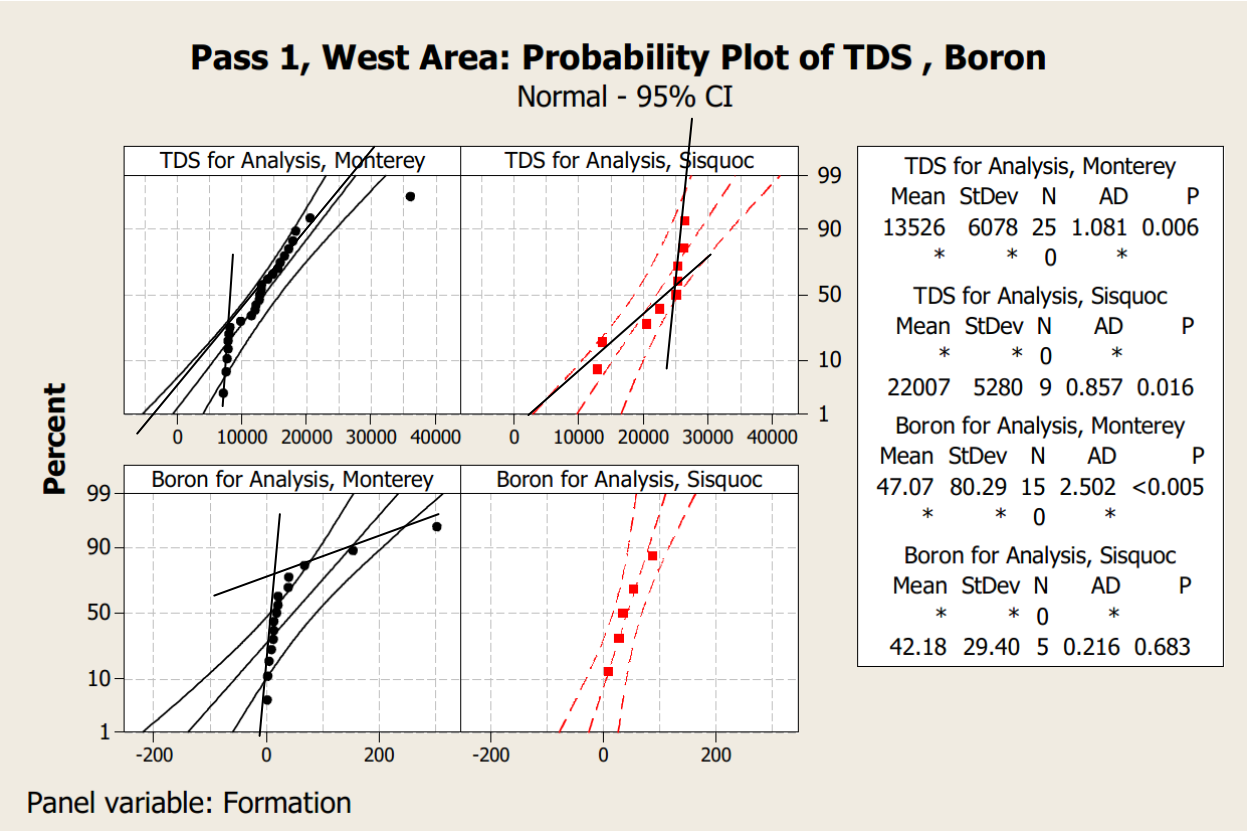

Figure 2.3-4

2.3.4 Central Area

Figure 2.3-5, Pass1: Central Area Probability Plot of TDS, Boron, shows the probability plots of the first pass analysis of the Central Area. The Central Area has one very low outlier (Fullerton Tank: [TDS] = 50 mg/L TDS) indicating either an analytical error or the water was actually treated water from a process such as Reverse Osmosis. This value was rejected.

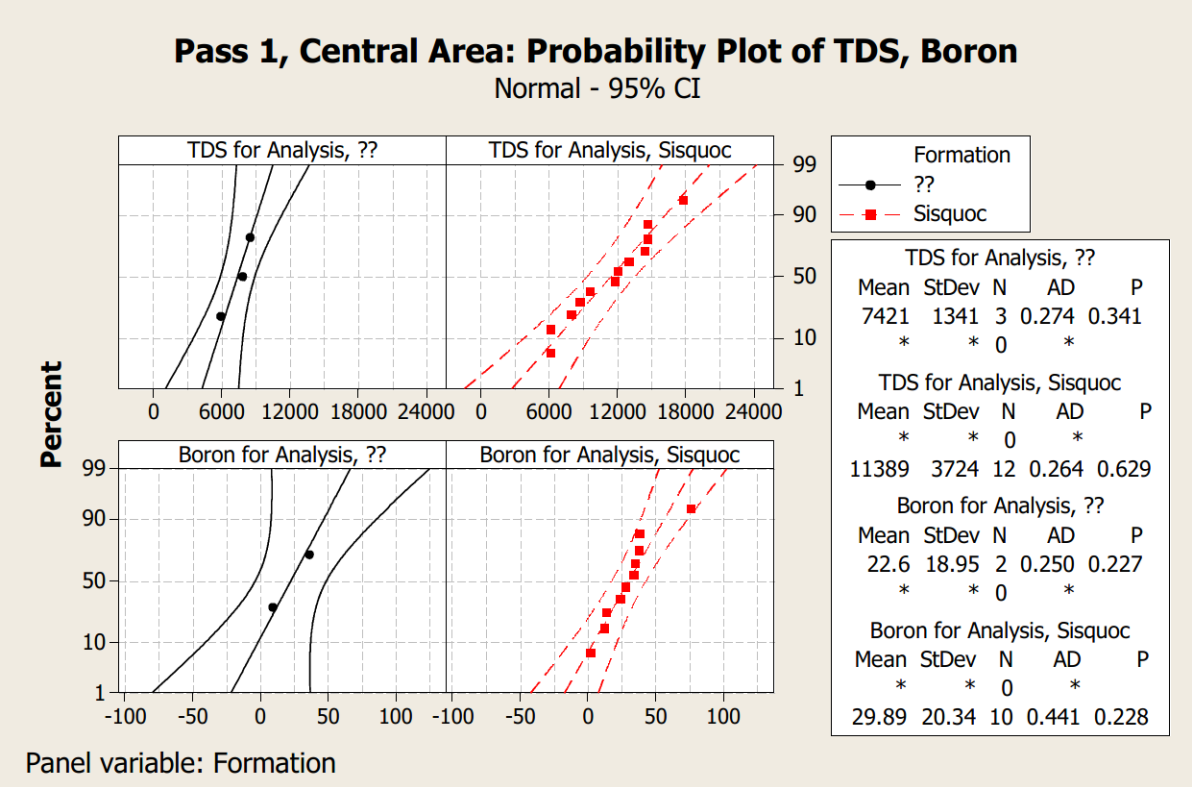

Figure 2.3-5

2.3.5 Gato Ridge Area

Figure 2.3-5, Pass1: Gato Ridge Area Probability Plot of TDS, Boron shows the probability plots of the first pass analysis of the Gato Ridge Area. One sample appeared to be an outlier based on correlation data for the Gato Ridge Area as well as its description (name): "Gato Canyon Ranch Freshwater well", (340 mg/L). This sample was rejected. There were 15 unassigned samples, these were not rejected and were carried forward for further consideration. All unassigned samples appear to be associated with the Monterey formation. The data exhibits a certain level of skewness possibly due to: chemical treatment waste, mislabeled formation assignment, slotted completions in multiple formations, differing depths of completion or attributable to the possible presence of a sealing fault (with isolated Monterey Formation elements).

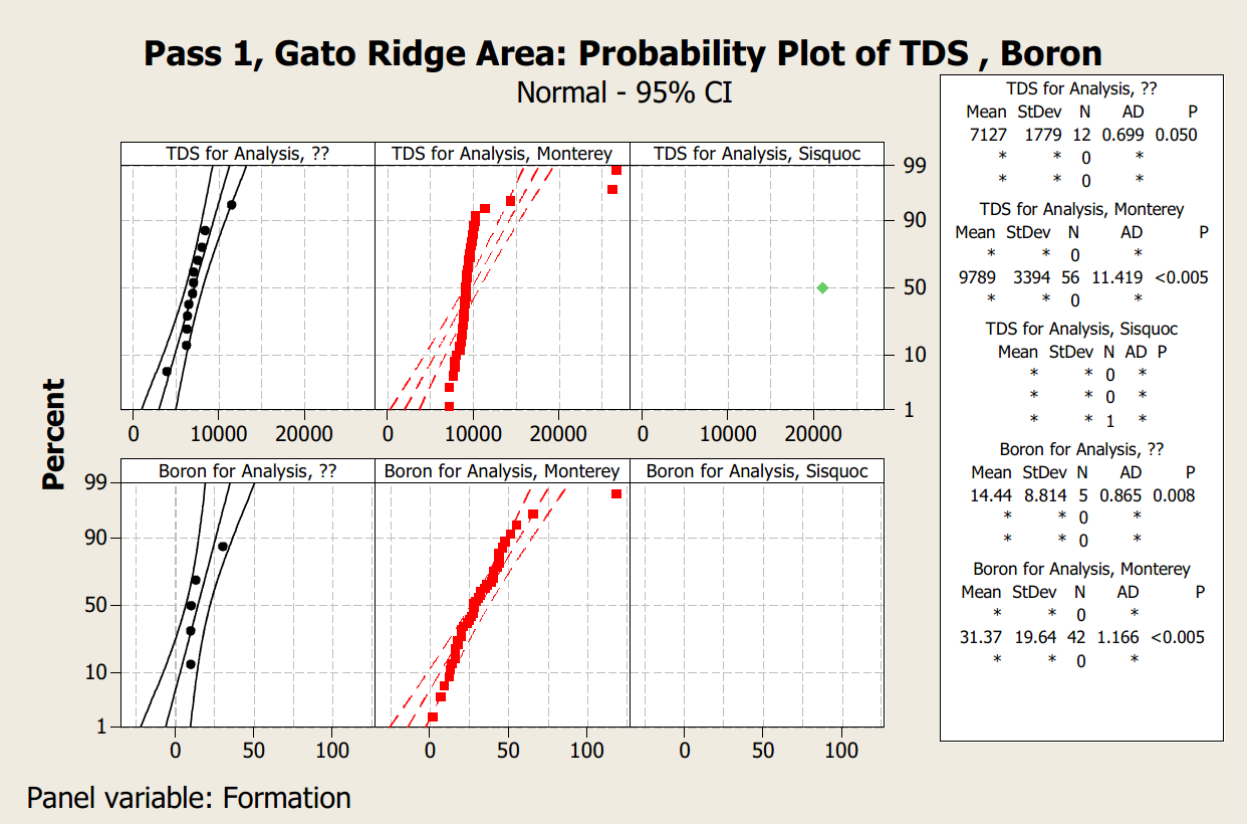

Figure 2.3-6

2.3.6 Rejected Values from First Pass

The table below summarizes the rejected values from the Pass 1 data set. There were several surviving values with [TDS] between 1000 mg/L and 3000 mg/L (potentially fresh to brackish sources) that were candidates for rejection but there was no evidence supporting their rejection at this point in the review. They were kept for later consideration. The general mean ± standard deviation allowed for consideration of some of values below 3,000 mg/L in the undifferentiated Sisquoc Sands sample cohort. However, the separation of the Sisquoc Sands samples in native formation and post steamed condensate samples and using the basic principal of maximum likelihood shifts the reasonable expectation (that data between 1000 mg/L and 3000 mg/l likely belong to condensate or groundwater sources, (Young, 1962). Other unassigned values were not rejected; they were reported as ("??") in the summary data unless the value could be properly assigned.

Table 3.2-1: Pass 1 Low TDS Rejected Samples

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Sub-formation	TDS for Analysis	Boron for Analysis	Notes
E9b	3/1/2014		Sisquoc	Tunnel	Water Well	Fresh	Paso Robles	??	980	0.16	??
B15b		8320830	East	Recruit Fee	Recruit Fee FW5-25	WS	??		240	0.00	water source well
B15c		8321005	East	Recruit Fee	Recruit Fee FW6-25	WS	??		180	0.00	Water source well
B6	7/14/1975		East	Bonetti	Bonetti #1	WS	??		499	1.00	Water well
B7c	7/22/1965		East	??	Brooks Oil Co Well #1??	WW	??		1183		turned into WD in 1967
B9			Central	Fullerton	Fullerton Tank #2	Fresh	WS		50	0.22	water well
15	9/6/2016		Gato Ridge	Gato Canyon Ranch	Freshwater Well	WS	??		340		??

2.4 Second Pass High Value Rejection

In this pass, values were considered in the context of bias in the higher [TDS] values. Samples from sources were labeled “Waste Water”, “WW” and some “WD”. Wells labeled WD were checked to make they were not correctable to WF. These samples were considered for rejection if no evidence was found indicating the sample was representative of connate formation water.

In some instances the samples derived from wells labeled WD are samples presented to DOGGR as samples from a specific formation pursuant to a UIC Project Approval Letter (PAL) were kept. However, these samples may not have been properly sampled. These samples may not have been bailed sufficiently to ensure that no drilling fluids or other confounding sources of water are overwhelming the actual connate water.

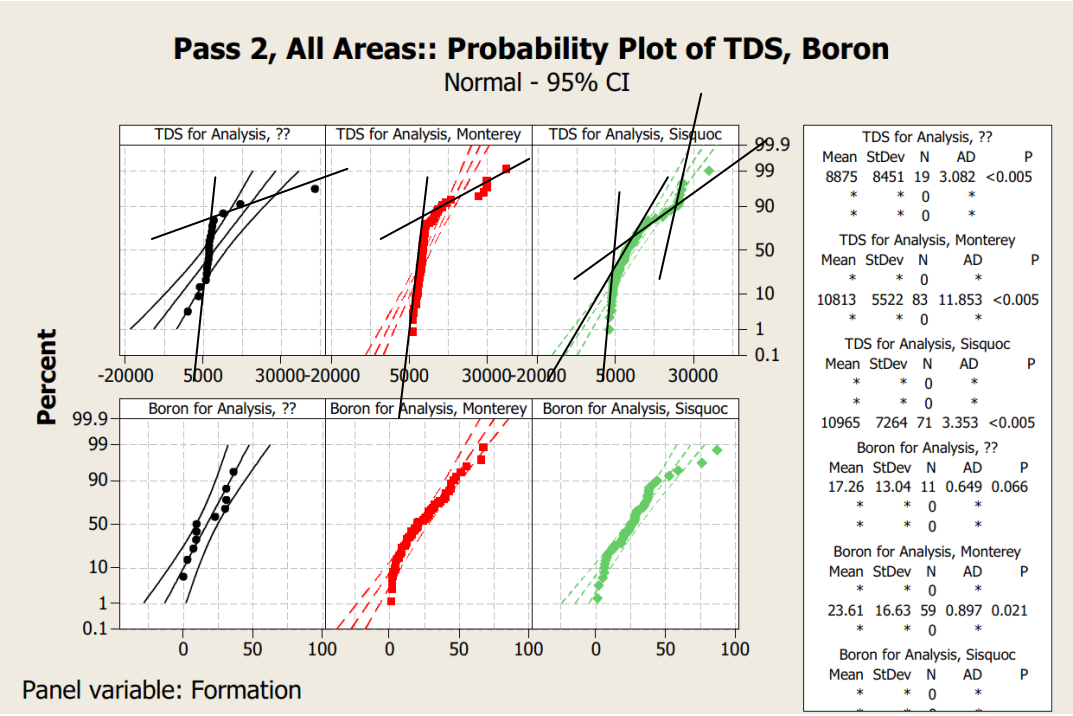

Figure 2.4-1

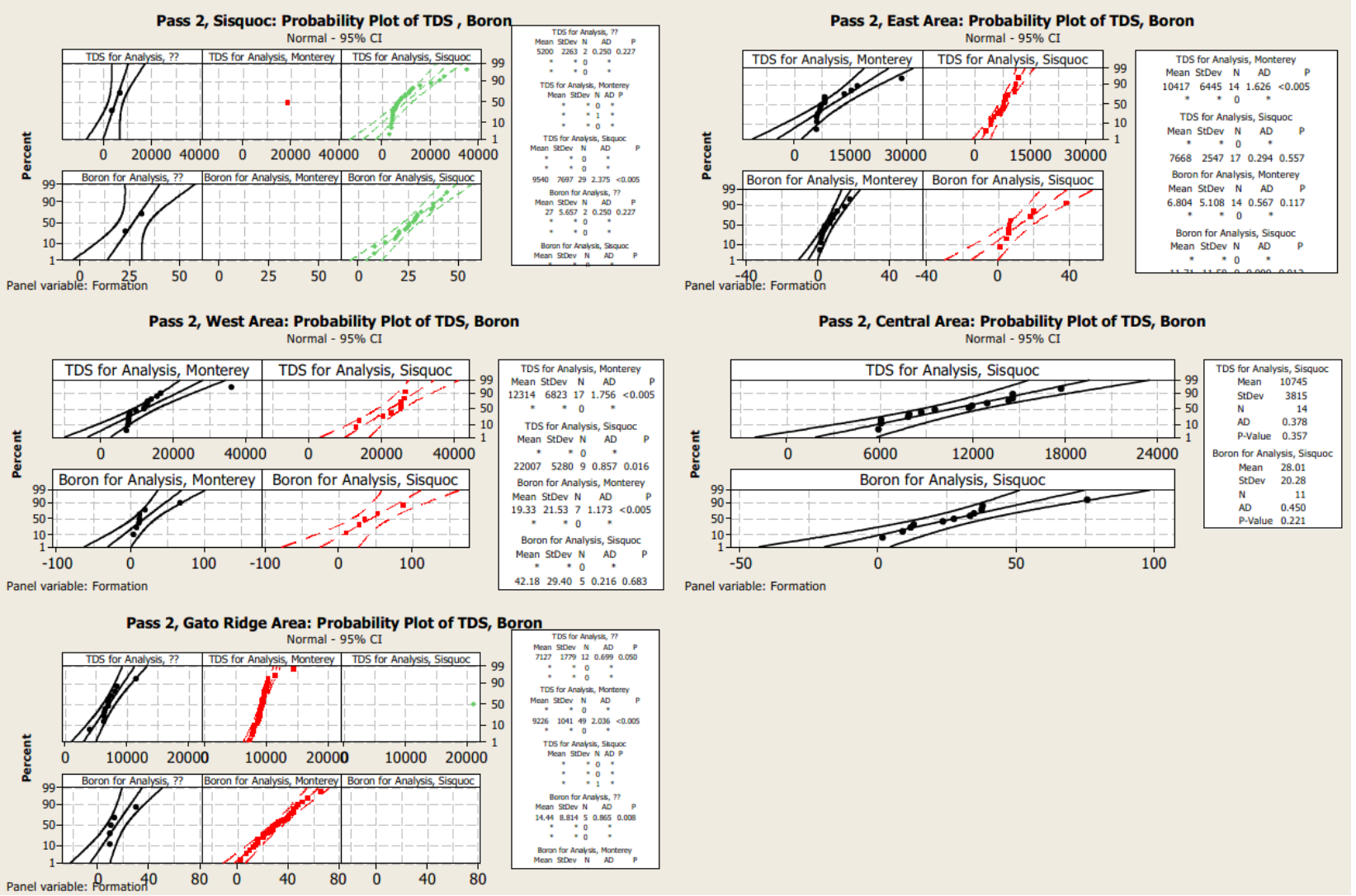
Pass 2, Sisquoc: Probability Plot of TDS , Boron
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, ??
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation
Pass 2, East Area: Probability Plot of TDS, Boron
Normal - 95% CI
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation
Pass 2, West Area: Probability Plot of TDS, Boron
Normal - 95% CI
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation
Pass 2, Central Area: Probability Plot of TDS, Boron
Normal - 95% CI
TDS for Analysis, Sisquoc
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation
Pass 2, Gato Ridge Area: Probability Plot of TDS, Boron
Normal - 95% CI
TDS for Analysis, ??
TDS for Analysis, Monterey
TDS for Analysis, Sisquoc
Boron for Analysis, ??
Boron for Analysis, Monterey
Boron for Analysis, Sisquoc
Percent
Panel variable: Formation

Figure 2.4-2

2.4.1 Sisquoc Area

In the Sisquoc Area the Sisquoc Sands samples exhibited some skewness. The Sisquoc Area shows the consistent residual pattern expected from the steam dilution effect in the Sisquoc Sands when samples were gathered from producing wells before the entire steam volume had been cleared from the formation or indicate that the data are grouped according to the presence of the isolated subformations in the Sisquoc Sands; the latter being less likely within a specific confined area of the Sisquoc Sands as a contiguous formation of numerous sands. Several potential composition elements exist (black lines). One high value for which no formation information was provided was rejected: Tunnel Facility ([TDS] =41,000mg/L).

A separate analysis for the Sisquoc Area, Sisquoc Sands post-steam impacts is provided later in this review; see **Section 2.5, Final Results**.

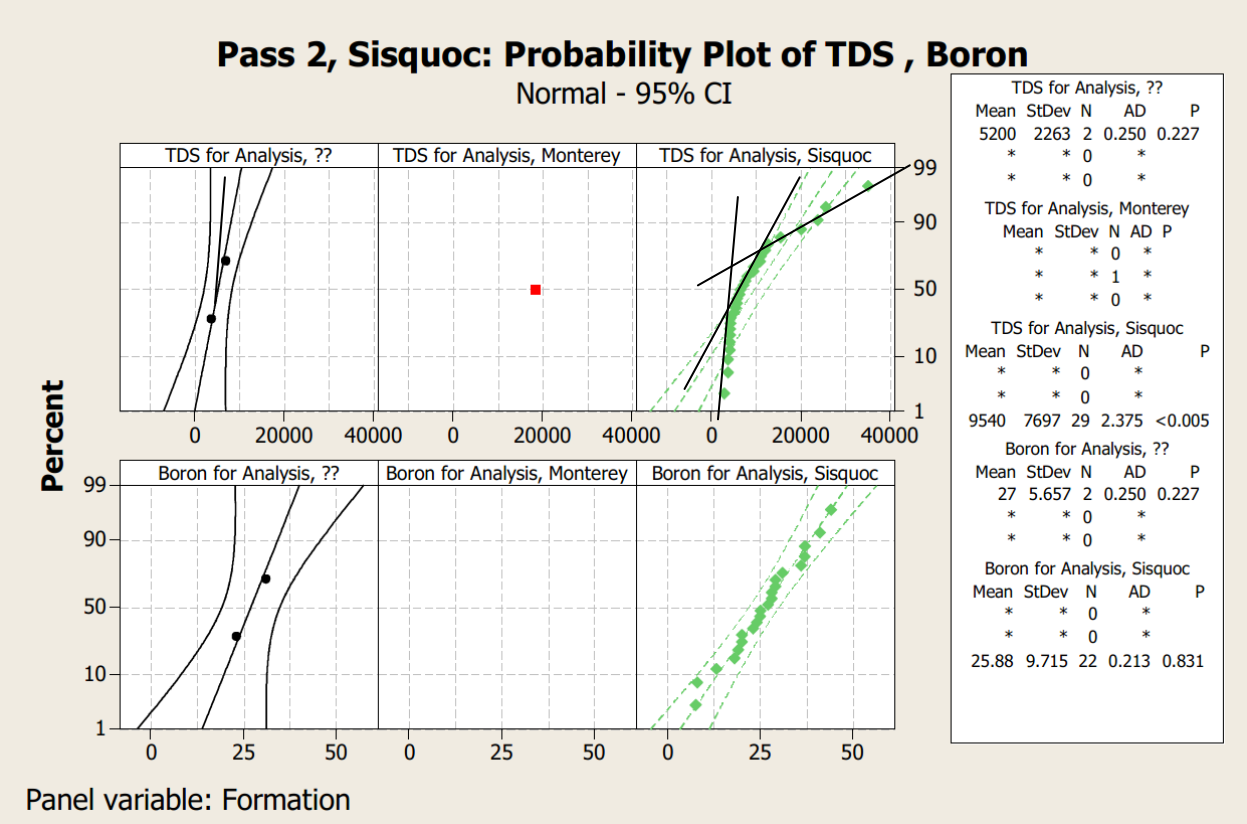

Figure 2.4-3

2.4.2 East Area

The East Area data appeared to be highly skewed in the Monterey Formation with a breakpoint at 9,000 mg/L (black lines).

Other unassigned samples appeared to be incorrectly assigned and were checked for possible reassignment to the Sisquoc formation. The remaining Sisquoc Sands data gave the false impression that the Sisquoc Sands [TDS] was lower than the Monterey formation [TDS]. While this was possible, the likely explanation is that undocumented post-steam samples were confounding the assessment, see section **2.5, Final Results**. Nine samples were rejected: Shell Field "WW" (7,018 mg/L), Combined Area "WW" (8,232 mg/L), Field Fee "WD" (6,631 mg/L), Husky OC "WW Tank" (4,662 mg/L), Texaco "WW" (3,770 mg/L), SWEPI "WW" (3,103 mg/L), Brooks "WW" (1158 mg/L), Victory Disposal (1,041 mg/L).

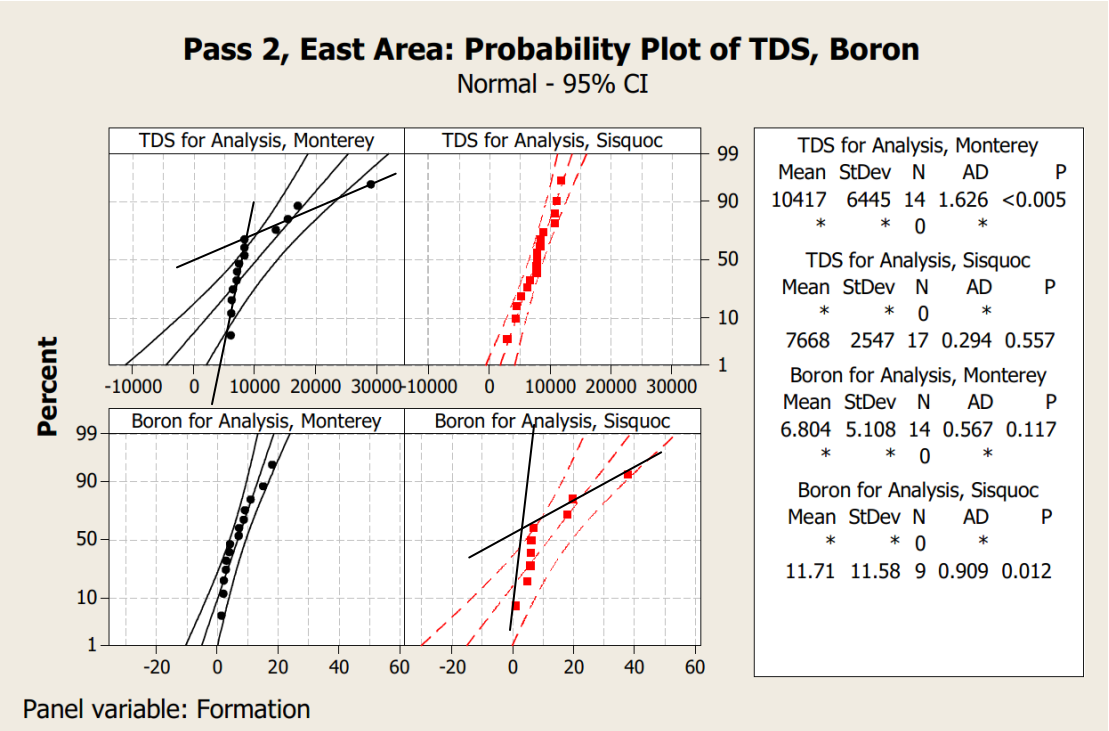

Figure 2.4-4

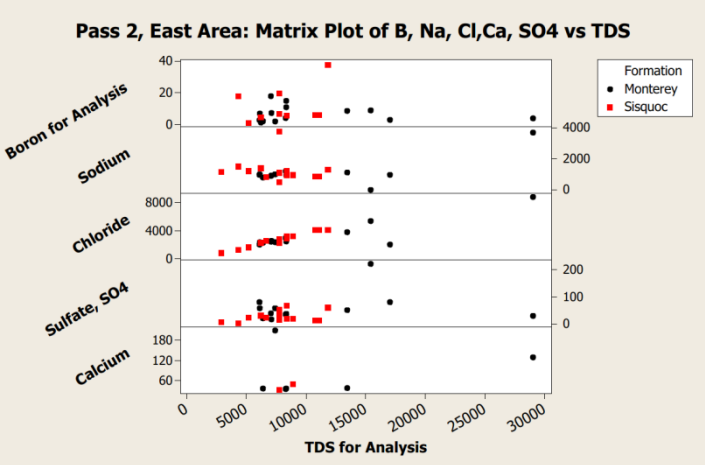

Figure 2.4-5

2.4.3 West Area

The West Area data indicated the pattern expected from a fault separation (Monterey formation samples TDS< 10,000 mg/L and TDS >10,000 mg/L) providing potential evidence of a fault-related isolation/confinement. Several potential formation elements existed (black lines).

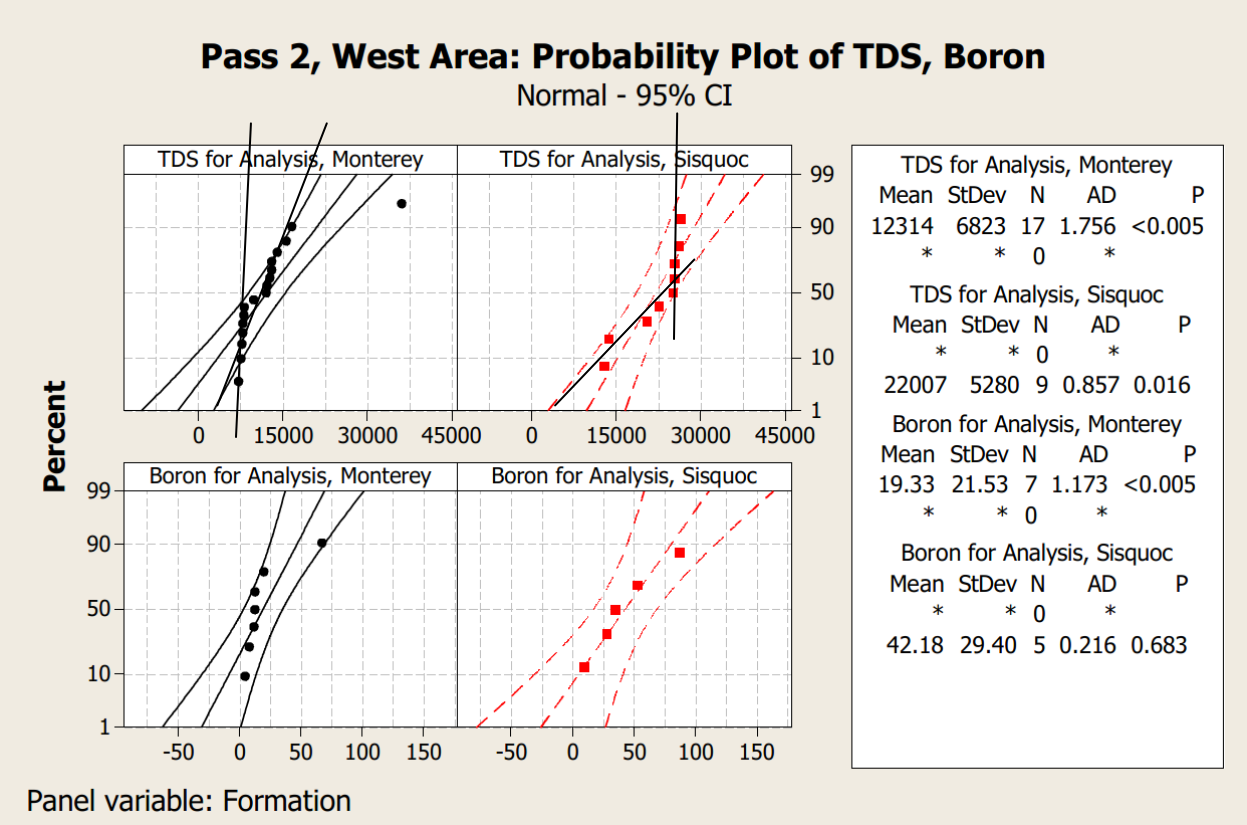

Figure 2.4-6

2.4.4 Central Area

The Sisquoc Sands water composition in the Sisquoc Area appeared to be relatively consistent from the low TDS region to the highest value recorded API No. 8300720 Los Alamos #54 (17,780 mg/L). No high data were rejected. Four unassigned samples remain, these were not rejected but as is the case in all unassigned samples they were included as such in the summary data unless the value could be properly assigned.

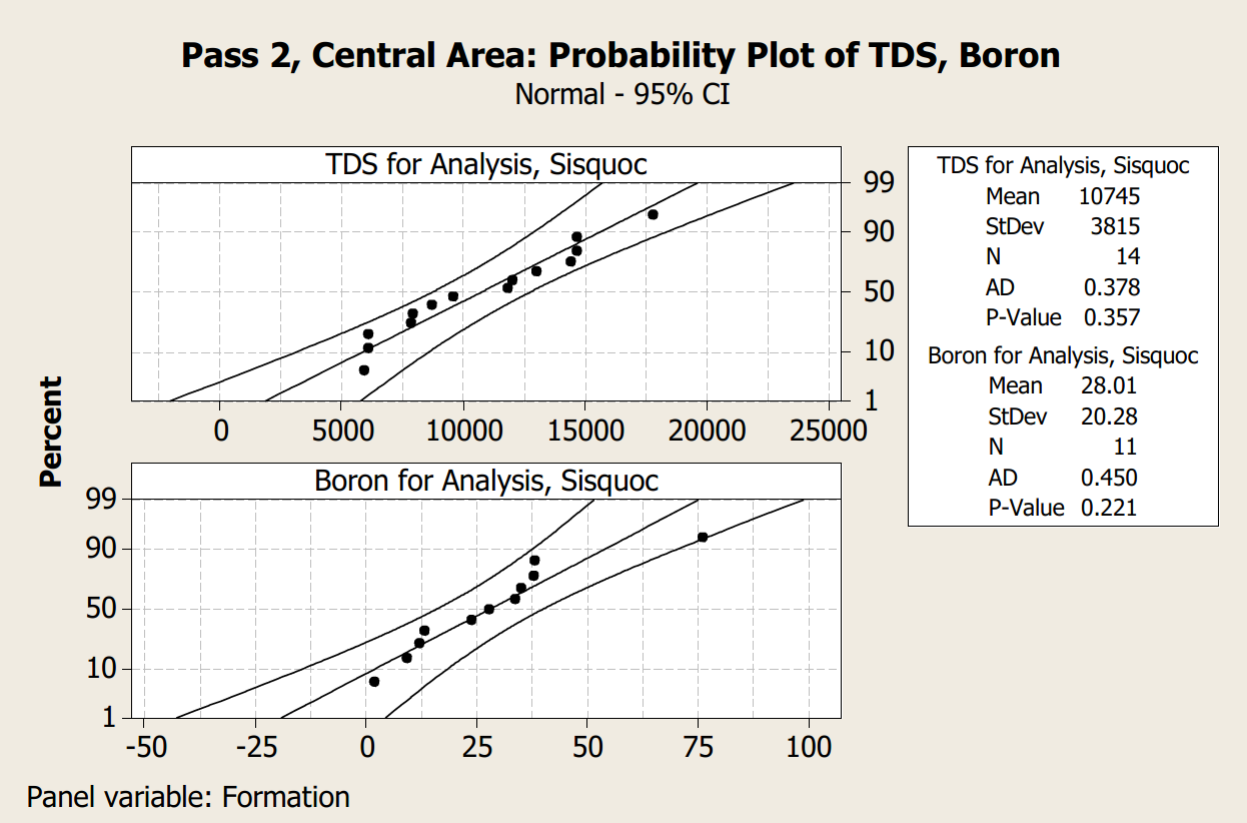

Figure 2.4-7

In the Central Area the Sisquoc Sands are steamed and water flooded therefore the lower values could be attributed to steam condensate diluting the formation water during the production cycle. Several samples showed typical random ranges of results, a review of the correlations show no inconsistencies in the formation analyses that would lead to a conclusion that the Central Area Sisquoc lower [TDS] samples were diluted. Therefore, the distribution is probably across Sisquoc sand elements that are isolated from one another by interposing silts and clays. When this was reviewed with operators, it was revealed that historically the Central Area operators had steamed and produced from the upper Sisquoc formations and reinjected the produced water into the Lower Sisquoc (S6 to S9) sands. Thus, the resultant samples leave false impression that the Central Area Sisquoc Sand native formation water is fresher than the native formation water may be. However, the purpose of the Formation Water Analysis was to simply determine appropriate water composition values for the Treatment Feasibility Study therefore the lower [TDS] values were not rejected.

2.4.5 Gato Ridge Area

Seven samples were rejected. There are two very high outliers reported for the Magenheimer lease as Tognazzini 3 or 17 ([TDS] = 26,706 mg/L and 26,225 mg/L). These values are presented as values reported in a hand written table with no supporting laboratory report. These values were rejected as not being representative of the Gato Ridge Monterey formation water composition, a review of the well history indicated that they are part of a fluorescence test conducted above the fracture pressure for which little detailed information was available. Two other values appeared to skew the Monterey formation data but were reviewed in the next section. Some of the 13 unassigned samples may be samples reflecting the multiple formation completions (Sisquoc and Monterey) due to slotted completions.

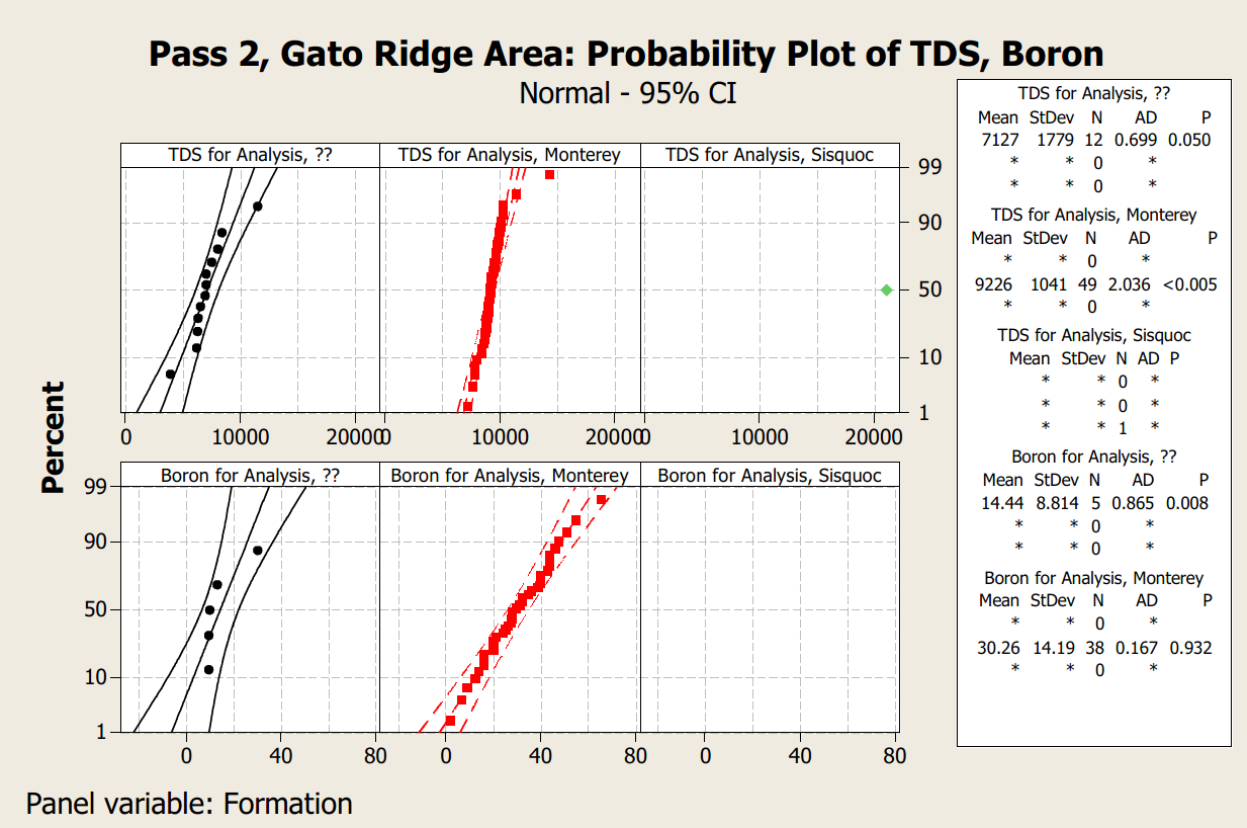

Figure 2.4-8

2.4.6 Rejected Values from Second Pass

The table below lists all values rejected in the second pass. Other unassigned values were not rejected in this pass. All unassigned samples they were reported as such ("??") in the summary data unless the value could be properly assigned.

Table 2.4-1 Rejected Samples

Reference No	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Sub-formation	TDS for Analysis
B1c	3/11/1985	??	East	SWEPI	WW	WW	Sisquoc		3103
E11	5/2/2014	??	Sisquoc	Tunnel	Tunnel Lease T-220	Tank	Sisquoc		3600
E6	5/19/2017	8322850.00	Sisquoc	Travis	Ardantz 711	SC Well PS	??		3600
B4a	4/28/1980	??	East	Texaco except Los Alamos		WW	Sisquoc		3770
E14	3/1/2017	??	Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc		4100
E13	10/1/2016	??	Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc		4100
B1d		??	East	Husky OC	WW tnk	WW	Sisquoc		4662
E8	1/1/2013	??	Sisquoc	Tunnel	Facility	Tank	Sisquoc		5100
B7a	10/22/1971	8320043.00	East	Field Fee		WD	Sisquoc	Brooks	6631
B3	3/31/1983	??	East	Shell Field Fee	WW	WW	Monterey		7018
E74	7/29/1964	??	Gato Ridge	Tognazzini	Tognazzini waste water	WW	Monterey		7195.2
B4d-g	3/5/1990	??	East	??	Comb WW Except Los Alamos	WW	Sisquoc		8232
E33	5/18/1983	??	Gato Ridge	Tognazzini	Tognazzini waste water	WW	Monterey		8924

2.4.7 Data Corrected in Pass 2 and Carried to Pass 3

Various records, scheduled for rejection, were further reviewed against other DOGGR records and with the applicants and those records (for which satisfactory explanation were found) were updated to be included in the Final Review, Appendix II, All Surviving Data.

Table 2.4-2 Records Revised After Review and Carried into Pass 3

Reference No	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis
C11	3/29/1963	8300370	Sisquoc	Porter	18	Well	Sisquoc	S8-Thomas	26100
E86	7/24/1962	8300370	Sisquoc	Porter	18	Well	Sisquoc	Basal Sisquoc	26100
E30	12/1/1983	8301400	Gato Ridge	Tognazzini	Tog 315	WD	Monterey		9660.9
E47	11/5/1976	8301455	Gato Ridge	Tognazzini	TOGNAZZINI #17 SWD	WD	Monterey		7630.43
B11b	5/5/1976	8301655	Gato Ridge	Tognazinni	Tog 43-A	WD	??		11500
B11a	7/16/1992	8301453	Gato Ridge	Tognazzini	Well 15 WW	WW	??		8390
E77	5/10/2006	8301302	West	Brooking	Brooking 54	Well	Monterey		36000
F3	10/8/1982	8321721	West	Los Alamos	LA 162	Well	Monterey		16549
E73		8301252	West	Los Flores	LOS FLORES NO. 77 - 21	Well	Monterey		15563
E23	11/30/1981	8321400	West	White	White 1	Well	Monterey		14000
E66	6/1/1974	8301427	West	Dominion/UCB	DOMINION #47	Well	Monterey		13048.96
E68	2/10/2012	8320232	West	Los Alamos	Los Alamos 156	Well	Monterey		13010
E71	6/1/1974	8320646	West	Dominion/UCB	UCB #1	Well	Monterey		12713.65
F2	12/11/1974	8320137	West	Los Alamos	LA 153	Well	Monterey		12176
F4a	1/18/1984	8321839	West	Los Alamos	LA 165	Well	Monterey		12049
E54		8301424	West	Dominion/UCB	DOMINION WELL NO 38	Well	Monterey		9828.32
E56	2/10/2012	8321719	West	Los Alamos	Los Alamos 160	Well	Monterey		8130
E60	2/10/2012	8321720	West	Los Alamos	Los Alamos 161	Well	Monterey		8030
E76		8301492	West	Bell	BELL NO. 12	Well	Monterey		7890
F1	7/7/1976	8300395	West	Los Alamos	Well 23	Well	Monterey		7880
F4b	1/18/1984	8321720	West	Los Alamos	LA 161	Well	Monterey		7714
B1e2	6/21/1966	8300662	West	R&G	0-40	Well	Monterey		7572
F4c	10/13/1983	8320232	West	Los Alamos	LA 156	Well	Monterey		7177
E111	10/22/1974	8300435	West	UCB	UCB O-12	Well	Sisquoc	S1B	26444
E103	4/20/1971	8300350	West	Los Alamos	Los Alamos 2	Well	Sisquoc	S2-S5	26153.9
E110	10/22/1974	8300012	West	UCB	UCB O-18	Well	Sisquoc	S1B	25369
C18	10/22/1974	8300012	West	UCB	0-18	Well	Sisquoc	Sib	25360
E109	10/18/1974	8300137	West	UCB	UCB O-23	Well	Sisquoc	S1B	25100
E118	4/24/1953	8301331	West	Alexander	Alexander 154	Well	Sisquoc	S6	22543.9
E93	7/17/1972	8301509	West	Bell	Bell 39	Well	Sisquoc	S2-S6A	20461
E92	3/12/1980	8300381	West	Los Alamos	Los Alamos 1	Well	Sisquoc	S2-S5	13730
E94	6/12/2012	8322760	West	Los Alamos	Los Alamos 325	Well	Sisquoc	S6-S9	12903
B18a	4/20/1971	8300313	Central	Los Alamos	Los Alamos #31	WF	Sisquoc		7929
B5b	3/4/1966	8300313	Central	Los Alamos	Los Alamos 31	WF	Sisquoc		7844
I1	8/1/2014	8322656	Sisquoc	Tunnell	Tunnell S-2	SC Well PS	Sisquoc	Upper Sisquoc	3200.00
I2	6/1/2017	8322666	Sisquoc	Tunnell	Tunnell S-17	SC Well PS	Sisquoc	Upper Sisquoc	3600.00
I3	6/1/2017	8322885	Sisquoc	Ardantz	Ardantz 511	SC Well PS	Sisquoc	Upper Sisquoc	5400.00
I4	10/13/2016	8322871	Sisquoc	Travis	Travis 1WD	Well	Sisquoc	Upper Sisquoc	9400.00
I5	5/12/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	9500.00
I6	6/1/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	11000.00
I7	11/27/2013	8322599	Sisquoc	Travis	Travis 201	Well	Sisquoc	Upper Sisquoc	12000.00

2.5 Final Results

For the final review, all unattributed data were reviewed and rejected in the absence of reliable formation reference; wells showing evidence of facility treatment were rejected as potentially carrying brine from water softeners as well as other reject from water treatment equipment.

In a separate analysis, steaming wells (SC) and associated tankage were separately assessed to establish the near well radius effects due to steaming dilution. Native formation water composition was determined by looking only at wells (OG and SC) that are not identified as Post Steaming during steam/production cycles. Sub-formation elements of the Sisquoc and fault impact elements were separated and assessed.

A review of the surviving samples against the DOGGR 2016 Data Base for Oil and Gas Wells shows that samples were populated by wells that are Cyclic Steam Injection (SC) wells. Most were in the Central and East Area and completed in the Sisquoc formation.

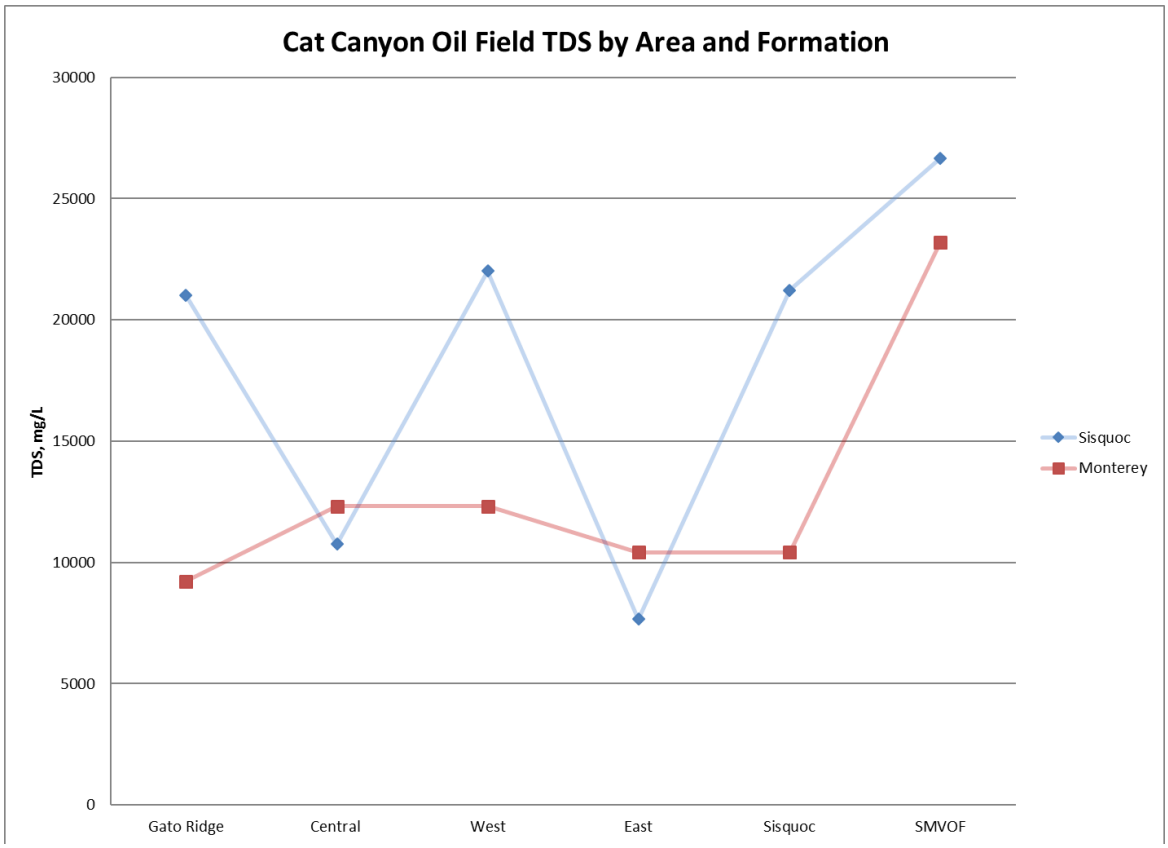

Figure 2.5-1

2.5.1 Sisquoc Area

Data from the Siquoc Area, Sisquoc Sands contained a unique set of well documented samples that allow assessment of the impact of steam injection of the determination of formation water. **Figure 2.5-2**, Probability Plots of the Sisquoc Area continued to show the pattern presumed to be due to steaming related dilution of formation samples. This was particularly

evident in the skewed Sisquoc formation samples, possibly reflected in the nine unassigned values as well (however, these values were rejected if not assignable to a formation). Boron did not show the characteristic skew found in the TDS, Sodium and Chloride probability plots. The steaming effect on borates appeared to be in proportion to the amount of steaming that takes place at a specific well.

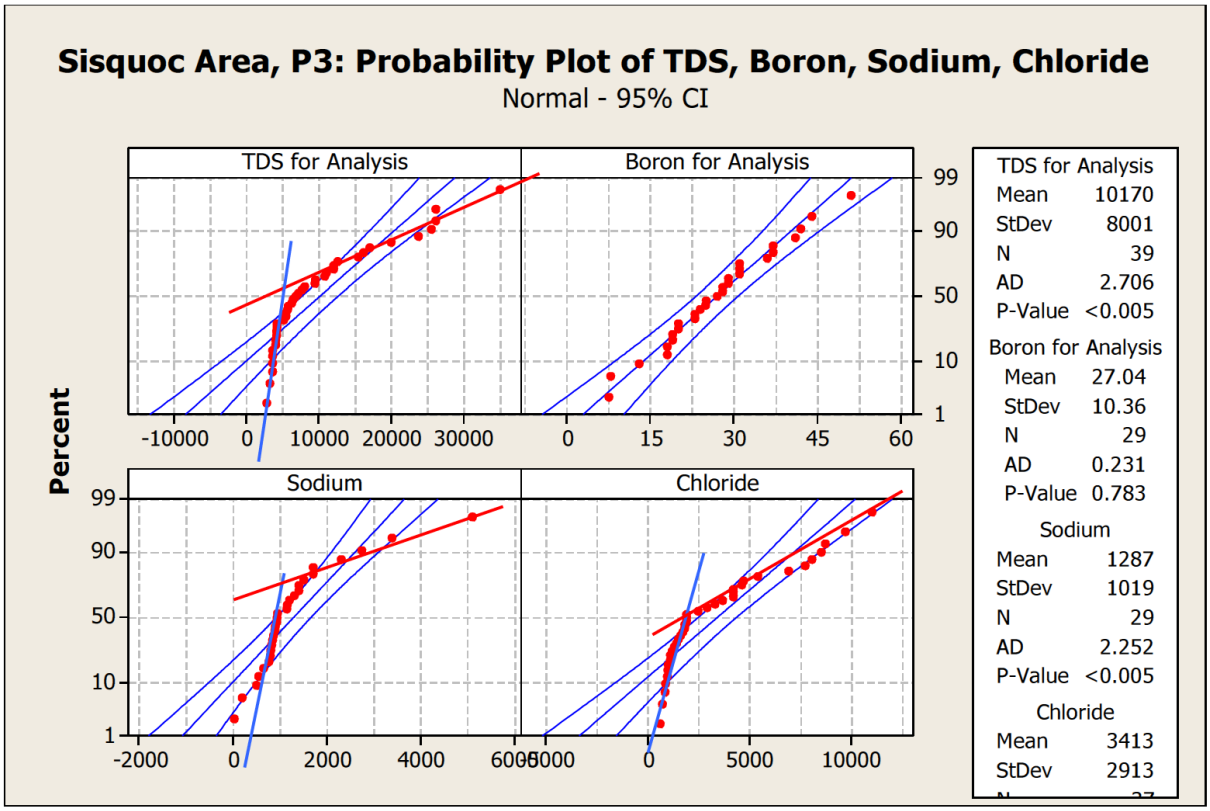

Figure 2.5-2

Table 2.5.1-1 Pass 3: All Sisquoc Area Data

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E84	2/11/1985	8320423	Sisquoc	United California	United California 51	SC Well PS	Sisquoc	S1B	12550.00	27.98
E119	1/16/1985	8321106	Sisquoc	Harbordt	Harbordt 3-16	SC Well PS	Sisquoc	Basal Sisquoc	10786.00	24.90
E98	12/12/2013	8300710	Sisquoc	GWP	GWP 11-13	SC Well PS	Sisquoc	Basal Sisquoc	7980.00	7.56
E99	12/12/2013	8321860	Sisquoc	Cantin	Cantin 40	SC Well PS	Sisquoc	Basal Sisquoc	7610.00	7.84
G7	6/8/2017	8322599	Sisquoc	Travis	Travis 201	SC Well PS	Sisquoc	S2-S8	6400.00	37.00
G8	6/8/2017	8322819	Sisquoc	Travis	Travis 203	SC Well PS	Sisquoc	S9	6200.00	44.00
G2	6/8/2017	8322599	Sisquoc	Travis	Travis 201	SC Well PS	Sisquoc	S2-S8	5700.00	41.00
E108	2/6/1975	8320393	Sisquoc	Tunnell	Tunnell 15	SC Well PS	Sisquoc	Basal Sisquoc	5683.70	*
G6	6/8/2017	8322662	Sisquoc	Tunnell	Tunnell S11	SC Well PS	Sisquoc	S8 / S9	5400.00	31.00
E8	1/1/2013		Sisquoc	Tunnel	Facility	Tank	Sisquoc	??	5100.00	25.00
E10a	5/1/2014		Sisquoc	Tunnel	All Tunnel Wells	Tank	Sisquoc	??	4200.00	23.00
G3	6/8/2017	8322657	Sisquoc	Tunnell	Tunnell S3	SC Well PS	Sisquoc	S1b / S2	4200.00	20.00
E14	3/1/2017		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4100.00	28.00
E13	10/1/2016		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4100.00	27.00
E12	11/3/2015		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4000.00	29.00
E10b	5/1/2014		Sisquoc	Tunnel	Tunnel Lease T-210	Tank	Sisquoc	??	4000.00	24.00
E11	5/2/2014		Sisquoc	Tunnel	Tunnel Lease T-220	Tank	Sisquoc	??	3600.00	20.00
G4	6/8/2017	8322666	Sisquoc	Tunnell	Tunnell S17	SC Well PS	Sisquoc	S1b / S2/ s9	3600.00	18.00
E4	7/1/2014	8322656	Sisquoc	Tunnel	S-2 Post Steam	SC Well PS	Sisquoc	S2	2800.00	19.00
E9	3/1/2014		Sisquoc	Tunnel	All wells Produced Water year2	SC Well PS	Sisquoc	??	6800.00	31.00
E6	5/19/2017	8322850	Sisquoc	Travis	Ardantz 711	SC Well PS	Sisquoc	??	3600.00	23.00
E107	2/6/1975	8320368	Sisquoc	Cantin (Recruit??)	Cantin 24 (21-25??)	SC Well PS	Sisquoc	Basal Sisquoc	7153.30	*
E2	4/1/2012	8322602	Sisquoc	Tunnel	S-10	SC Well	Sisquoc	S8/S9	35000.00	13.00
E85	2/3/1970	8320222	Sisquoc	Security Fee	Security Fee 1	Well	Sisquoc	Thomas/Basal Sisquoc	25495.00	*
E120	10/31/1975	8320792	Sisquoc	Mortensen	Mortensen 14-6	SC Well	Sisquoc	Thomas/Basal Sisquoc	23705.00	*
E87	4/26/1982	8321702	Sisquoc	Hunter Resources	HR-OPI 13-17	Well	Sisquoc	Basal Sisquoc	19995.00	*
C14	4/26/1982	8321702	Sisquoc	HR-OPI	HR OPI 13-7	Well	Sisquoc	S9	15400.00	*
E3	11/23/2013	8322599	Sisquoc	Travis	Travis 201	Well	Sisquoc	S2-S8	12000.00	*
C11	3/29/1963	8300370	Sisquoc	Porter	18	Well	Sisquoc	S8-Thomas	26100.00	*
E86	7/24/1962	8300370	Sisquoc	Porter	18	Well	Sisquoc	Basal Sisquoc	26100.00	*
E116	12/1/1980	8321465	Sisquoc	GWP	GWP WD2-13	WD	Sisquoc	S1B-S5	16153.00	19.00
I1	8/1/2014	8322656	Sisquoc	Tunnell	Tunnell S-2	SC Well PS	Sisquoc	Upper Sisquoc	3200.00	18.00
I2	6/1/2017	8322666	Sisquoc	Tunnell	Tunnell S-17	SC Well PS	Sisquoc	Upper Sisquoc	3600.00	31.00
I3	6/1/2017	8322885	Sisquoc	Ardantz	Ardantz 511	SC Well PS	Sisquoc	Upper Sisquoc	5400.00	29.00
I4	10/13/2016	8322871	Sisquoc	Travis	Travis 1WD	Well	Sisquoc	Upper Sisquoc	9400.00	36.00
I5	5/12/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	9500.00	37.00
I6	6/1/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	11000.00	*
I7	11/27/2013	8322599	Sisquoc	Travis	Travis 201	Well	Sisquoc	Upper Sisquoc	12000.00	41.97
J1	5/31/2017	8321524.00	Sisquoc	GWP	GWP 738	Well	Sisquoc	S1b	17000.00	51.00

Figure 2.5-3, showed no specific covariance. With the exception of GWP WD2-13 (a 500 bbl Swab Sample for a PAL) a cluster below [TDS] = 13,000 mg/L and a cluster above [TDS] = 20,000mg/L (highlighted in blue and red) form. Most boron samples are found in sample data reporting TDS below 13,000 mg/L. [Boron] when present at the higher [TDS] (i.e., when both are reported) is lower than the projection using all of the boron data. Some sodium samples (S-10 and Security Fee 1) skew the Sodium trend possibly due to mis-labeling, poor sampling, poor lab results or some formation mineralogy creating zeolitic reduction in Sodium.

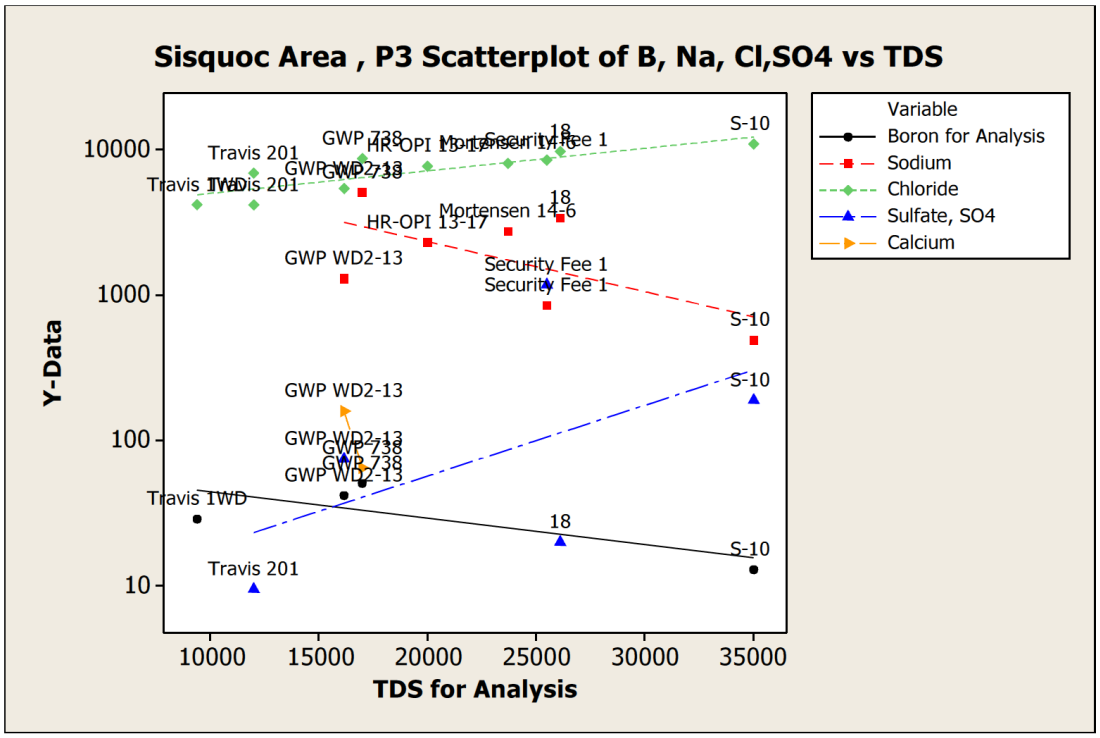

Figure 2.5-3

The lowest Sisquoc Post Steam [TDS] values are likely samples gathered closer to the cessation of injection and the start of the production cycle, when the greatest amount of condensate is returned. The Sisquoc Post Steam samples having higher [TDS] are assumed to be closer to the termination of production as the steam condensate is depleted and production of fluids slow to the point at which injection is once again scheduled in the EOR project.

The probability plot below, **Figure 2.5-4,** shows the clearly identified and documented post-steam injection samples marked as ("SC Well PS"). The probability plot shows that these specific samples are not representative of the formation water itself but rather these represent samples of condensate, dissolved native minerals and some connate water, the degree of which is dependent on the time of the sampling relative to the end of steam injection and the quality of the steam being injected at the start of the specific EOR cycle, assumed to be soft (no Calcium). One of the "WD" wells GWP WD2-13 is shown, note that the TDS falls in line with the centrus of the samples reported as Wells (representing the trend toward formation water). The formation water is likely to be found in the range specified by the Highest three values for

"Well" and the two values for "SC Wells" (red highlight). The lower values for "Well" are likely associated with the condensate skewed samples "SC Wells PS". GWP WD2-13 (a sample taken after 500 bbl were bailed) is probably a connate sample (29,353 mg/L) partially confounded by the remnants of produced water ("SC Well PS" [TDS] = 6,146 mg/L) that was likely provided by the operator to the driller for drilling fluids. This underscores the importance of more extensive bailing when regulatory actions and related decisions may be driven by faulty sampling of post drilling fluid in well bores.

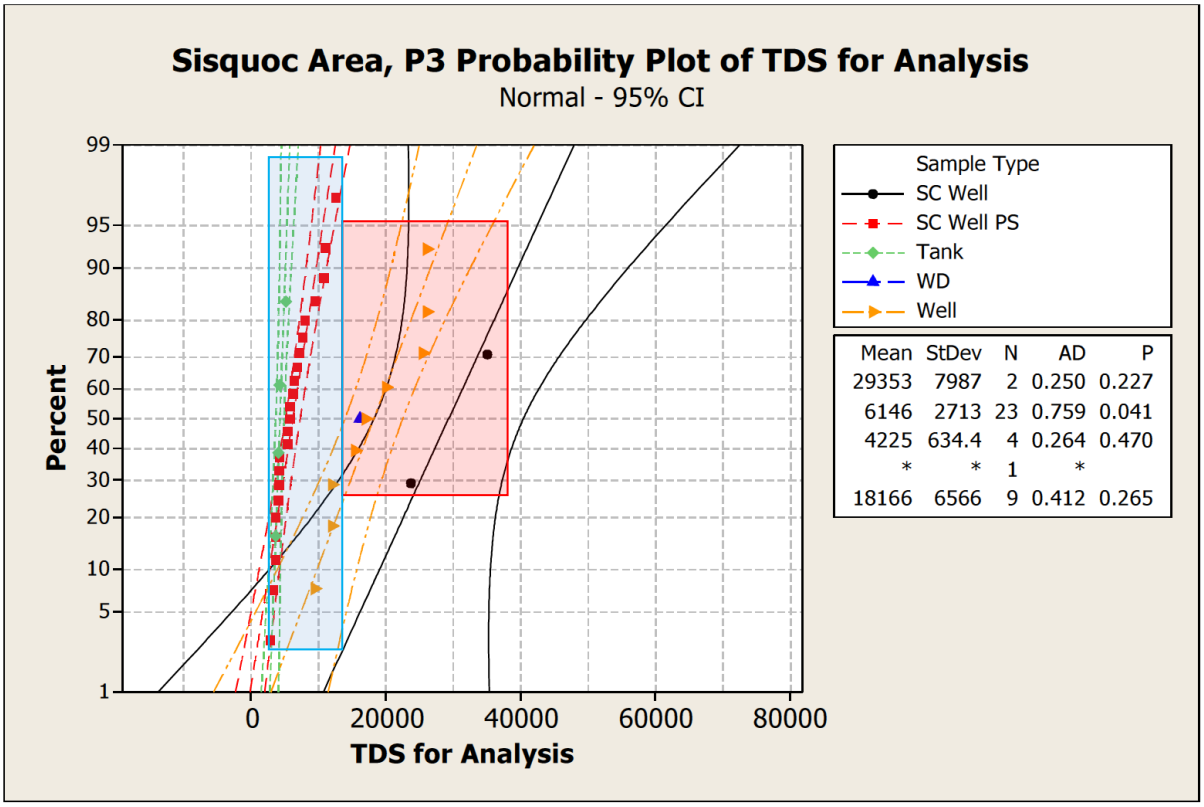

Figure 2.5-4

2.5.1.1 Sisquoc Sands Steaming Effect

The separation according to post-steaming status of the Sisquoc Area Sisquoc Sands samples is shown in more detail below. The results indicate that Canyon Oil Field Sisquoc Sands sample data may consistently understate the formation composition by some degree of dilution.

The data indicate that samples below 10,000mg/L are likely diluted by the active steaming in the Sisquoc Sands in the Sisquoc Area. A review of the source data for the surviving Sisquoc Area Sisquoc Sands samples with [TDS]< 12,000 mg/L are identified in Vaquero files as being related to steam injection operations. **Table 2.5.1-2** shows those surviving samples that show evidence of being confounded by the produced condensate effect which dilutes the true formation TDS composition in the Sisquoc Sands.

Table 2.5.1-2 Sisquoc Area, Sisquoc Sands Samples affected by returning Produced Steam Condensate

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E84	2/11/1985	8320423	Sisquoc	United California	United California 51	SC Well PS	Sisquoc	S1B	12550.00	27.98
E119	1/16/1985	8321106	Sisquoc	Harbordt	Harbordt 3-16	SC Well PS	Sisquoc	Basal Sisquoc	10786.00	24.90
E98	12/12/2013	8300710	Sisquoc	GWP	GWP 11-13	SC Well PS	Sisquoc	Basal Sisquoc	7980.00	7.56
E99	12/12/2013	8321860	Sisquoc	Cantin	Cantin 40	SC Well PS	Sisquoc	Basal Sisquoc	7610.00	7.84
G7	6/8/2017	8322599	Sisquoc	Travis	Travis 201	SC Well PS	Sisquoc	S2-S8	6400.00	37.00
G8	6/8/2017	8322819	Sisquoc	Travis	Travis 203	SC Well PS	Sisquoc	S9	6200.00	44.00
G2	6/8/2017	8322599	Sisquoc	Travis	Travis 201	SC Well PS	Sisquoc	S2-S8	5700.00	41.00
E108	2/6/1975	8320393	Sisquoc	Tunnell	Tunnell 15	SC Well PS	Sisquoc	Basal Sisquoc	5683.70	
G6	6/8/2017	8322662	Sisquoc	Tunnell	Tunnell S11	SC Well PS	Sisquoc	S8 / S9	5400.00	31.00
E8	1/1/2013		Sisquoc	Tunnel	Facility	Tank	Sisquoc	??	5100.00	25.00
E10a	5/1/2014		Sisquoc	Tunnel	All Tunnel Wells	Tank	Sisquoc	??	4200.00	23.00
G3	6/8/2017	8322657	Sisquoc	Tunnell	Tunnell S3	SC Well PS	Sisquoc	S1b / S2	4200.00	20.00
E14	3/1/2017		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4100.00	28.00
E13	10/1/2016		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4100.00	27.00
E12	11/3/2015		Sisquoc	Tunnel	Produced Garey Area Wells	SC Well PS	Sisquoc	??	4000.00	29.00
E10b	5/1/2014		Sisquoc	Tunnel	Tunnel Lease T-210	Tank	Sisquoc	??	4000.00	24.00
E11	5/2/2014		Sisquoc	Tunnel	Tunnel Lease T-220	Tank	Sisquoc	??	3600.00	20.00
G4	6/8/2017	8322666	Sisquoc	Tunnell	Tunnell S17	SC Well PS	Sisquoc	S1b / S2/ s9	3600.00	18.00
E4	7/1/2014	8322656	Sisquoc	Tunnel	S-2 Post Steam	SC Well PS	Sisquoc	S2	2800.00	19.00
E9	3/1/2014		Sisquoc	Tunnel	All wells Produced Water year2	SC Well PS	Sisquoc	??	6800.00	31.00
E6	5/19/2017	8322850	Sisquoc	Travis	Ardantz 711	SC Well PS	Sisquoc	??	3600.00	23.00
E107	2/6/1975	8320368	Sisquoc	Cantin (Recruit??)	Cantin 24 (21-25??)	SC Well PS	Sisquoc	Basal Sisquoc	7153.30	
I1	8/1/2014	8322656	Sisquoc	Tunnell	Tunnell S-2	SC Well PS	Sisquoc	Upper Sisquoc	3200.00	19.00
I2	6/1/2017	8322666	Sisquoc	Tunnell	Tunnell S-17	SC Well PS	Sisquoc	Upper Sisquoc	3600.00	18.00
I3	6/1/2017	8322885	Sisquoc	Ardantz	Ardantz 511	SC Well PS	Sisquoc	Upper Sisquoc	5400.00	31.00
I5	5/12/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	9500.00	36.00
I6	6/1/2017	8322869	Sisquoc	Ardantz	Ardantz 506	SC Well PS	Sisquoc	Upper Sisquoc	11000.00	37.00

Table 2.5.1-3 shows the samples that trend to, or represent, the actual native formation water composition of the Sisquoc Sands in the Sisquoc Area. These waters would be the water actually produced by a community service well, were it able to produce sufficient water.

Table 2.5.1-3 Sisquoc Area, Sisquoc Formation Samples Not affected by Steam Condensate

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E2	4/1/2012	8322602	Sisquoc	Tunnel	S-10	SC Well	Sisquoc	S8/S9	35000.00	13.00
E85	2/3/1970	8320222	Sisquoc	Security Fee	Security Fee 1	Well	Sisquoc	Thomas/Basal Sisquoc	25495.00	
E120	10/31/1975	8320792	Sisquoc	Mortensen	Mortensen 14-6	SC Well	Sisquoc	Thomas/Basal Sisquoc	23705.00	
E87	4/26/1982	8321702	Sisquoc	Hunter Resources	HR-OPI 13-17	Well	Sisquoc	Basal Sisquoc	19995.00	
C14	4/26/1982	8321702	Sisquoc	HR-OPI	HR OPI 13-7	Well	Sisquoc	S9	15400.00	
E3	11/23/2013	8322599	Sisquoc	Travis	Travis 201	Well	Sisquoc	S2-S8	12000.00	
C11	3/29/1963	8300370	Sisquoc	Porter	18	Well	Sisquoc	S8-Thomas	26100.00	
E86	7/24/1962	8300370	Sisquoc	Porter	18	Well	Sisquoc	Basal Sisquoc	26100.00	
E116	12/1/1980	8321465	Sisquoc	GWP	GWP WD2-13	WD	Sisquoc	S1B-S5	16153.00	41.97
I4	10/13/2016	8322871	Sisquoc		Travis 1WD	Well	Sisquoc	Upper Sisquoc	9400.00	29.00
I7	11/27/2013	8322599	Sisquoc		Travis 201	Well	Sisquoc	Upper Sisquoc	12000.00	
J1	5/31/2017	8321524	Sisquoc	GWP	GWP 738	Well	Sisquoc	S1b	17000.00	51.00

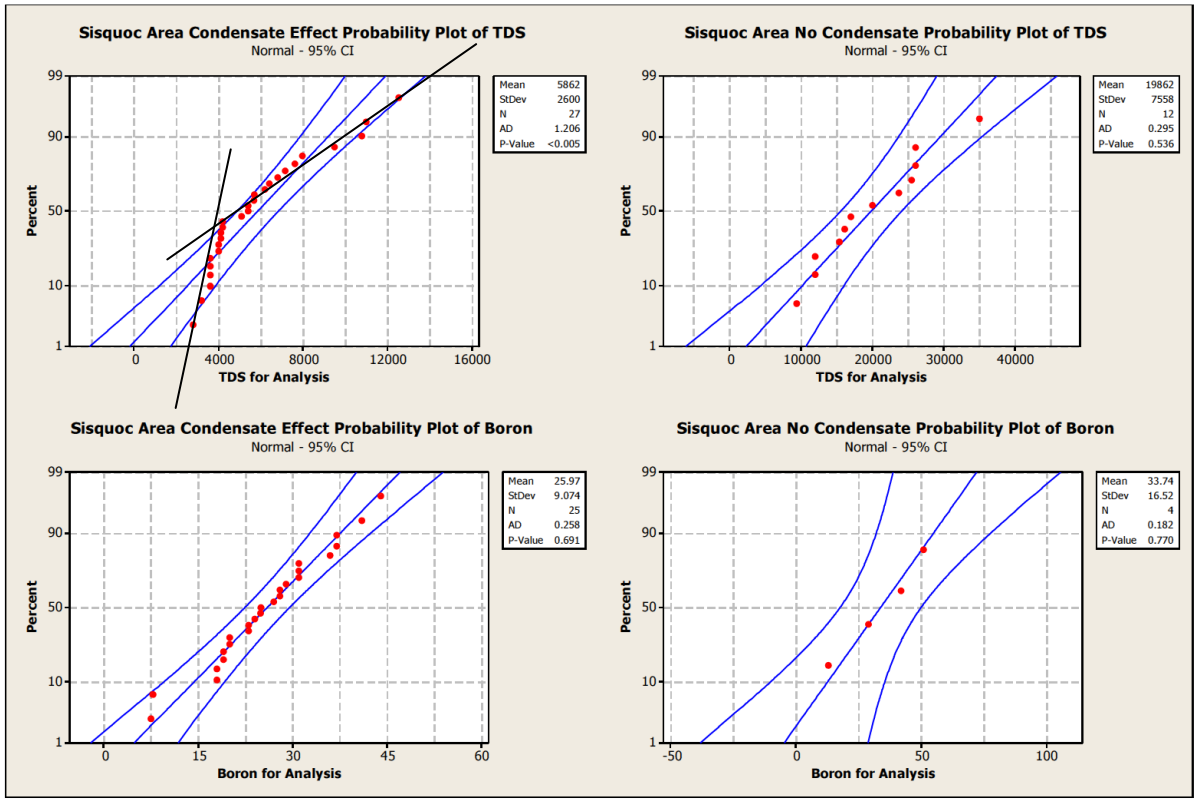

Figure 2.5-5

Data review indicated that steam injection may cause a 4:1 sample dilution bias (skewed to lower values) due to dilution of the formation water during production cycles. In the case of the Sisquoc Area where some Sisquoc Sands samples were well defined (as to post steam injection status) the average formation composition could randomly range around the all-in mean: from the (low end condensate driven value up to the no condensate mean). However, there is also a clear breakpoint in the condensate affected samples at about 4,100 mg/L. The [TDS] data below this point are probably associated with samples containing large volume of non-Sisquoc Sands water being introduced into the cycle. Whereas the [TDS] data above 4,100 mg/L are representative of samples that in various stages of mixing with condensate. The historic data were not gathered with this intent and most of the formation water quality analysis does not allow one to assign each sample to its individual circumstances (volumes of fluids produced since injection, time since injection, [TDS] of injectate, etc.)

For the purpose of Treatment Feasibility one must note that the facilities and wells from which these data were gathered are DOGGR regulated facilities and wells that would be abandoned according to state code. New wells for the drinking water project would likely be drilled into formations with area-wide historic oil production and completed in formation space that has not necessarily been subjected to the influence of steaming (unless drilled close to an abandoned cyclic well that was aggressively steamed and then promptly abandoned. Any wells that are in proximity to past steaming can only recover the near radius capture of any lingering steam condensate from the nearby (now abandoned wells). Thus, the yield of water would be that of connate water over the life of the water production project. The average producing well

in Cat Canyon Oil Field has been 2.9 gallons per minute for the past 5 years. Refer to Section 5, Aquifer Exemption Expansion Application Study.

2.5.2 East Area

The East Area showed some skewness in the Monterey formation, breaking at approximately 8,300 mg/L; however the Sisquoc formation showed consistent distribution. The two Field Fee samples: one, identified as "Brooks and Monterey", was rejected (as a waste water sample) and the other, a record showing Monterey Miocene, is reassigned to Monterey. Several potential formation elements exist (black lines).

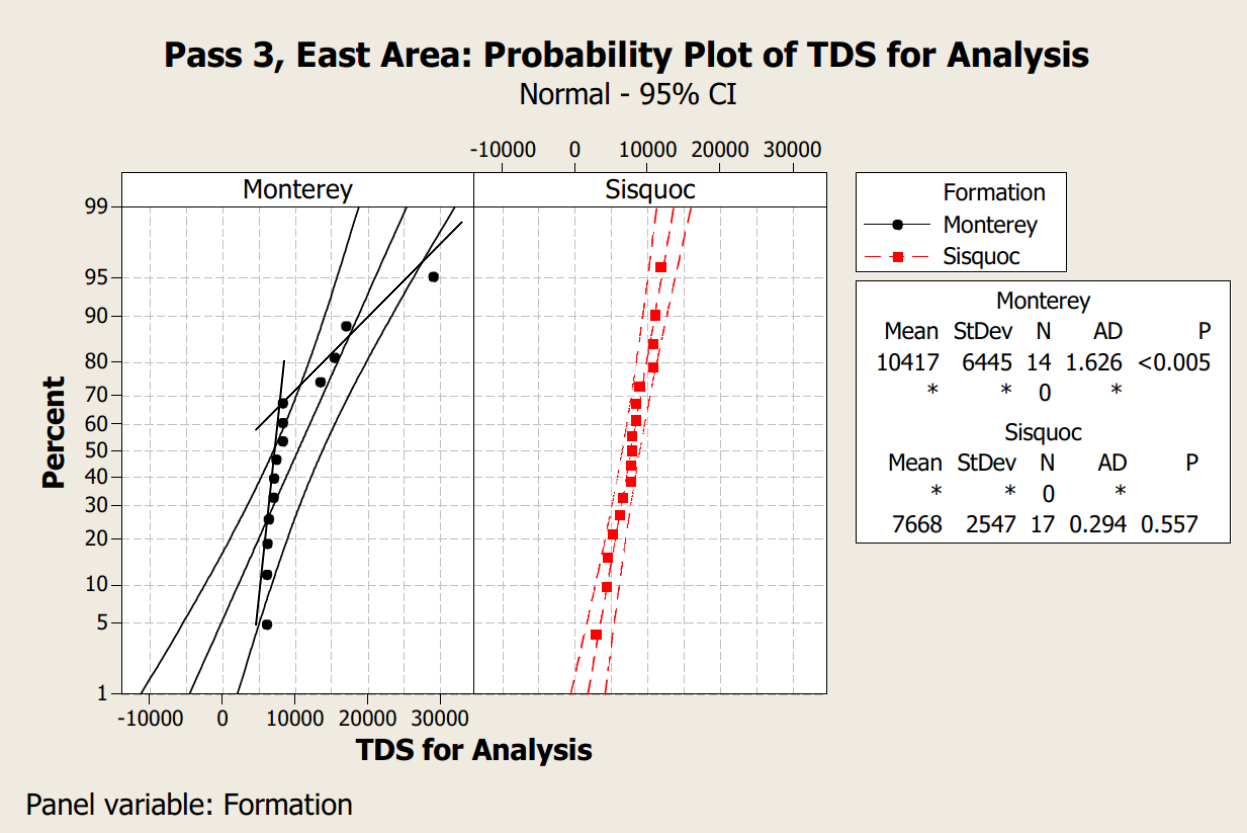

Figure 2.5-6

Table 2.5.2-1 East Area Formation Water

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis
E82	9/20/2014	8300728	East	Williams Holding	Williams Holding 1-18	Well	Monterey		29000.00
D4	12/6/2012	8322693	East	ERG	VIC G-7 Step rate 1	Well	Monterey		15390.00
E67	2/10/2012	8300004	East	GWP	GWP 87-24	Well	Monterey		13420.00
D6	11/25/2013	8322765	East	ERG	West 9	Well	Monterey		8300.00
D5	11/25/2013	8322758	East	Fleisher	Fleisher D4-M	Well	Monterey		8300.00
E64	11/25/2013	8322765	East	West	West 9	Well	Monterey		8260.00
E70	11/25/2013	8322770	East	West	West 10	Well	Monterey		7380.00
B3	3/31/1983		East	Shell Field Fee	WW	WW	Monterey		7018.00
E81	8/11/1965	8301295	East	Williams B	Williams B-4	SC Well	Monterey		6172.00
D7	11/25/2013	8322770	East	ERG	West 10	Well	Monterey		6100.00
E83	3/11/1977	8321048	East	Williams B	Williams B-14	SC Well	Monterey		6070.00
E117	1/11/1979	8321180	East	GWP	GWP 46A-24	SC Well	Sisquoc	S2-S3	11800.00
E115	7/31/2013	8322691	East	Victory	Victory G1	Well	Sisquoc	S6-S8	11047.00
C6	7/13/2013	8322691	East	Victory	G1	Well	Sisquoc	S2-S9	10720.00
D1	7/31/2013	8322694	East	ERG	Cat Canyon 10 FLD G-2	Well	Sisquoc	S2-S8	10720.00
E90	10/22/1971	8320044	East	Field Fee	Field Fee 18	Well	Sisquoc	Brooks	8860.00
B1e1	6/21/1966	8301177	East	R&G	25	Well	Sisquoc		8358.00
B7b	10/29/1971	8320044	East	Field Fee	Field Fee 18-31	Well	Sisquoc	Brooks	8322.00
C5	12/10/2012	8321254	East	Recruit Fee	821-25	SC Well	Sisquoc	S1b	7800.00
D2	7/25/1967	8321048	East	Williams B	R-14-B	SC Well	Sisquoc	Brooks	7740.00
E106	11/14/1972	8320368	East	Recruit Fee	Recruit Fee 21-25	SC Well	Sisquoc	S1B	7710.00
E105	2/28/2012	8321563	East	Williams Holding	Williams Holding 835	SC Well	Sisquoc	S1B	7700.00
B7a	10/22/1971	8320043	East	Field Fee		WD	Sisquoc	Brooks	6631.00
F9	8/11/1965	8301295	East	Williams B	B-4	SC Well	Sisquoc		6172.00
D3	7/25/1967	8301310	East	ERG	Stendel 1	Well	Sisquoc	Brooks	5155.00
C7	2/1/1975	8300085	East	Westco-Petan	B75	Well	Sisquoc	S1b-S2	4455.00
B18b	7/8/1981		East	ERG	Produced Water to HWT	Tank	Sisquoc		4300.00
B4b	9/12/1980	8321160	East	Getty Oil	GWP 401-24	Well	Sisquoc	S1b	2870.00
F10	3/23/1977	8321048	East	Williams B	B-14	SC Well	Monterey		16995.00
B1e3	6/21/1966	8300270	East	R&G	0-45	Well	Monterey		7059.00
E75	9/12/2013	8321101	East	Williams Holding	Williams Holding 5	Well	Monterey		6370.00

2.5.3 West Area

Sisquoc formation showed potential signs of early return water sampling from the production cycle and a possible sealing fault passing through both Sisquoc and Monterey in the West Area. The sample API 08300313 Los Alamos 31 reported in the West Area sample was rejected from the West Area as incorrect completion location (it is correct for the sample to be attributed to the Central Area). Two Los Flores waste water samples and four Hunter Cat Wastewater samples were rejected. Several potential formation elements exist (black lines).

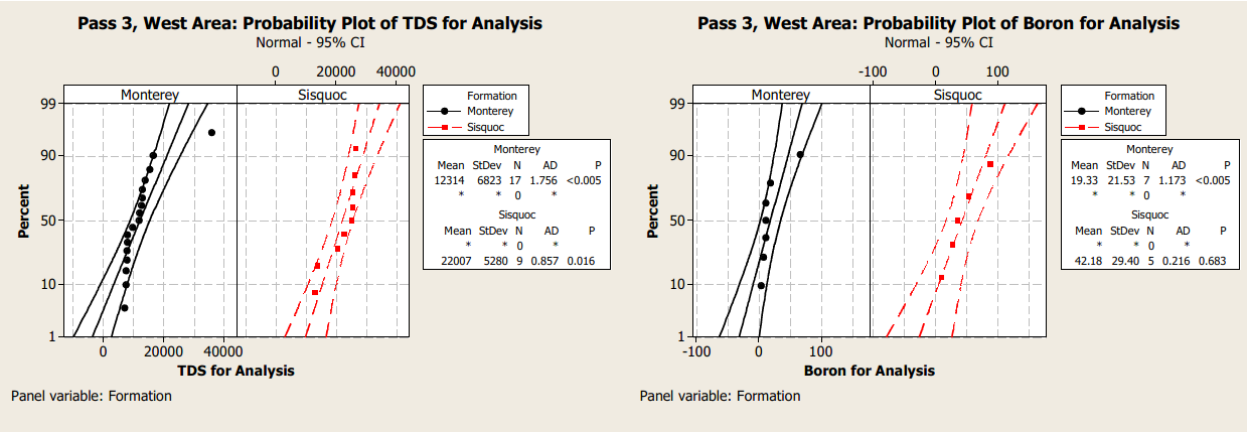

Figure 2.5-7

Table 2.5.3-1 West Area Formation Water

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E77	5/10/2006	8301302	West	Brooking	Brooking 54	Well	Monterey		36000.00	
F3	10/8/1982	8321721	West	Los Alamos	LA 162	Well	Monterey		16549.00	67.00
E73		8301252	West	Los Flores	LOS FLORES NO. 77 - 21	Well	Monterey		15563.00	
E23	11/30/1981	8321400	West	White	White 1	Well	Monterey		14000.00	19.59
E66	6/1/1974	8301427	West	Dominion/UCB	DOMINION #47	Well	Monterey		13048.96	
E68	2/10/2012	8320232	West	Los Alamos	Los Alamos 156	Well	Monterey		13010.00	12.31
E71	6/1/1974	8320646	West	Dominion/UCB	UCB #1	Well	Monterey		12713.65	
F2	12/11/1974	8320137	West	Los Alamos	LA 153	Well	Monterey		12176.00	
F4a	1/18/1984	8321839	West	Los Alamos	LA 165	Well	Monterey		12049.00	
E54		8301424	West	Dominion/UCB	DOMINION WELL NO 38	Well	Monterey		9828.32	
E56	2/10/2012	8321719	West	Los Alamos	Los Alamos 160	Well	Monterey		8130.00	12.31
E60	2/10/2012	8321720	West	Los Alamos	Los Alamos 161	Well	Monterey		8030.00	11.75
E76		8301492	West	Bell	BELL NO. 12	Well	Monterey		7890.00	4.37
F1	7/7/1976	8300395	West	Los Alamos	Well 23	Well	Monterey		7880.00	
F4b	1/18/1984	8321720	West	Los Alamos	LA 161	Well	Monterey		7714.00	
B1e2	6/21/1966	8300662	West	R&G	0-40	Well	Monterey		7572.00	8.00
F4c	10/13/1983	8320232	West	Los Alamos	LA 156	Well	Monterey		7177.00	
E111	10/22/1974	8300435	West	UCB	UCB O-12	Well	Sisquoc	S1B	26444.00	
E103	4/20/1971	8300350	West	Los Alamos	Los Alamos 2	Well	Sisquoc	S2-S5	26153.90	86.86
E110	10/22/1974	8300012	West	UCB	UCB O-18	Well	Sisquoc	S1B	25369.00	
C18	10/22/1974	8300012	West	UCB	0-18	Well	Sisquoc	Sib	25360.00	
E109	10/18/1974	8300137	West	UCB	UCB O-23	Well	Sisquoc	S1B	25100.00	
E118	4/24/1953	8301331	West	Alexander	Alexander 154	Well	Sisquoc	S6	22543.90	52.58
E93	7/17/1972	8301509	West	Bell	Bell 39	Well	Sisquoc	S2-S6A	20461.00	9.33
E92	3/12/1980	8300381	West	Los Alamos	Los Alamos 1	Well	Sisquoc	S2-S5	13730.00	34.70
E94	6/12/2012	8322760	West	Los Alamos	Los Alamos 325	Well	Sisquoc	S6-S9	12903.00	27.42

2.5.4 Central

Two samples were re-assigned to Sisquoc formation: Los Alamos 31 and Los Alamos 40. Two non-assigned samples were rejected: Williams and Williams 7. Several potential formation elements exist (black lines). One Los Alamos samples was identified as an injecate sample but the entry was reviewed and corrected, therefore the sample was kept.

Table 2.5.4-1 Central Area Formation Water

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E97	6/12/2012	8300720	Central	Los Alamos	Los Alamos 54	Well	Sisquoc	S6-S9	17780.00	27.70
C1	11/23/1981	8320400	Central	Los Alamos	96	SC Well	Sisquoc	S1b	14645.00	
E104	11/14/1974	8320400	Central	Los Alamos	Los Alamos 96	SC Well	Sisquoc	S1B	14645.00	33.58
E96	6/12/2012	8300417	Central	Los Alamos	Los Alamos 60	Well	Sisquoc	S6-S9	14396.00	38.06
E95	6/12/2012	8300022	Central	Los Alamos	Los Alamos 120	Well	Sisquoc	S6-S9	12985.00	23.79
E100	3/2/2012	8300403	Central	Los Alamos	Los Alamos 33	Well	Sisquoc	S6-S9	12000.00	13.15
E101	11/14/1974	8300418	Central	Los Alamos	Los Alamos 62	Well	Sisquoc	S1B	11800.00	37.78
E102	11/14/1974	8320367	Central	Los Alamos	Los Alamos 93	SC Well	Sisquoc	S1B	9580.00	34.98
E89	10/21/1981	8321640	Central	Los Alamos	Los Alamos 98	Well	Sisquoc	S2-S3	8710.00	1.82
B18a	4/20/1971	8300313	Central	Los Alamos	Los Alamos #31	WF	Sisquoc		7929.00	76.00
B5b	3/4/1966	8300313	Central	Los Alamos	Los Alamos 31	WF	Sisquoc		7844.00	
C3	4/28/1980	8300409	Central	Los Alamos	40	Well	Sisquoc	S6S9	6100.00	
E88	4/28/1980	8300409	Central	Los Alamos	Los Alamos 40	Well	Sisquoc	S6-S9	6100.00	12.03
B16a	6/20/1997		Central	Williams B	Williams #7	SC Well	Sisquoc		5920.00	9.20

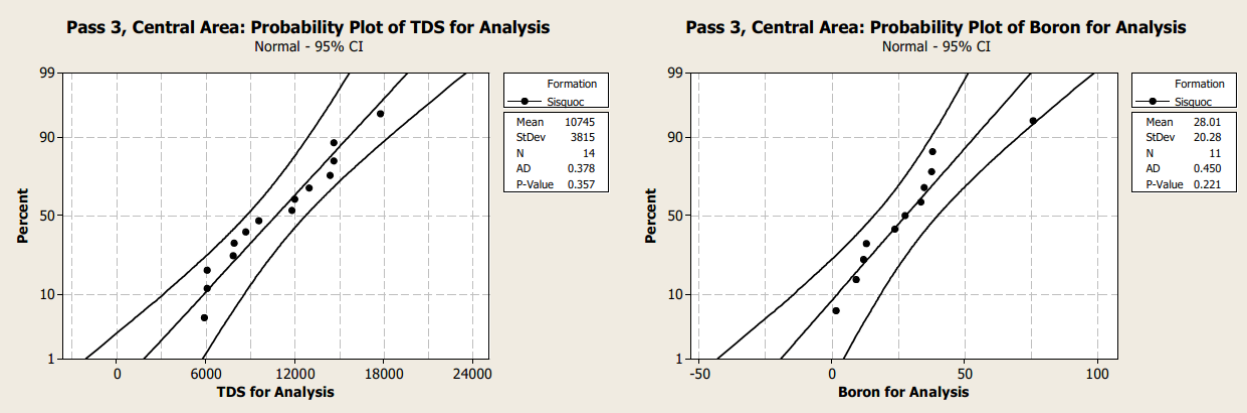

Figure 2.5-8

In the Central Area the Sisquoc Sands were steamed therefore the lower values could be attributed to steam condensate diluting the formation water during the production cycle. While several samples show typical random ranges of results, a review of the correlations show no inconsistencies in the formation analyses that would lead to a conclusion that the Central Area Sisquoc lower [TDS] samples were diluted. Therefore, the distribution may be attributed Sisquoc Sands elements that are isolated from one another by interposing silts and clays and the long term introduction of reinjected water.

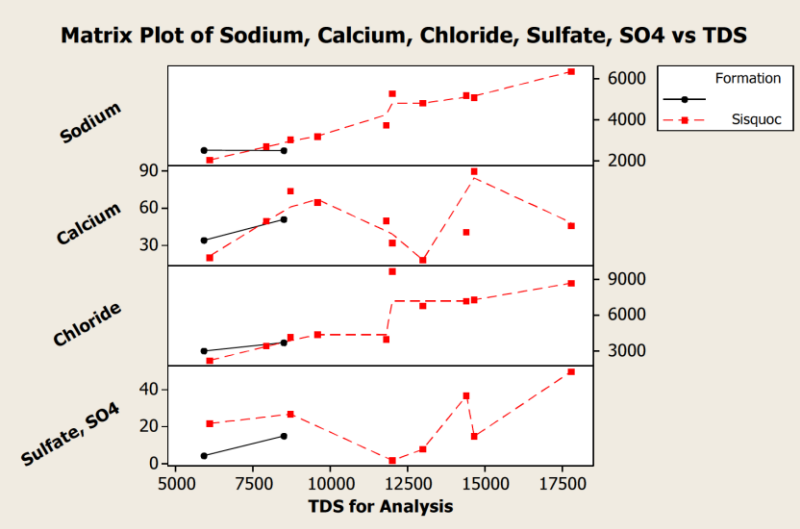

Figure 2.5-9

2.5.5 Gato Ridge Area

Gato Ridge data indicate that there were mostly Monterey Formation Completions in the Area. There were samples from some wells that were completed in both the Monterey and Sisquoc, however most production was expected to be from the Monterey Formation. One well (A-6) was a disposal well completed in the Sisquoc but it was a poor performer due to the limited reservoir space and was quickly abandoned. The table and the charts below show the results of the analysis.

Table 2.5.5-1 Gato Ridge Area Formation Water

Reference No.	Date	API Number	Area	Lease	Well Name/Description	Sample Type	Formation	Subformation	TDS for Analysis	Boron for Analysis
E49	8/30/1983	8301398	Gato Ridge	Tognazzini	Tog 1A	Well	Monterey		14278.00	15.95
E43	9/14/1983	8301398	Gato Ridge	Tognazzini	Tog 1A	WD	Monterey		11353.00	12.31
F5l	5/30/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		10225.00	
E15	10/13/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		10222.00	43.65
E79	5/14/2015	8301407	Gato Ridge	Tognazzini	Tog 51	Well	Monterey		10020.00	1.87
B12		8301407	Gato Ridge	Tognazzini	Tog 51	Well	Monterey		10000.00	6.70
E18	11/4/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		9906.00	34.70
E9	8/30/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9894.60	27.79
E14	11/4/1983	8301400	Gato Ridge	Tognazzini	Tog 315	WD	Monterey		9824.00	31.98
F5b	12/15/1983	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		9750.00	
E30	12/1/1983	8301400	Gato Ridge	Tognazzini	Tog 315	WD	Monterey		9660.90	39.79
E16	8/1/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		9633.00	19.84
E51	8/30/1983	8301407	Gato Ridge	Tognazzini	Tog 51	Well	Monterey		9604.00	15.95
E17	1/16/1984	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		9578.50	42.70
F5d	1/20/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		9450.00	
E46	1/20/1984	8301443	Gato Ridge	Tognazzini	Tog 3	Well	Monterey		9449.70	30.95
E61	1/16/1984	8301415	Gato Ridge	Tognazzini	Tog 349	Well	Monterey		9428.70	50.93
F5k	5/25/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		9365.00	
E40	2/3/1984	8301452	Gato Ridge	Tognazzini	Tog 14	Well	Monterey		9340.60	39.96
E31	8/1/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9227.00	21.04
E24	10/13/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9214.00	43.64
E41	12/1/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		9183.50	38.76
E22	11/4/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9161.00	36.03
F5c	12/29/1983	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		9143.00	
E19	9/14/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		9122.00	29.38
E37	12/1/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9121.10	46.03
F5g	3/7/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		9085.00	
E59	3/7/1984	8301443	Gato Ridge	Tognazzini	Tog 3	Well	Monterey		9084.50	65.51
E32	9/14/1983	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		9037.00	26.30
F6	5/25/1949	8301403	Gato Ridge	Tognazzini	Tog 23	Well	Monterey		8998.00	25.00
E27	10/13/1983	8301400	Gato Ridge	Tognazzini	Tog 315	Well	Monterey		8979.00	43.65
F5f	2/17/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		8926.00	
E57	2/17/1984	8301443	Gato Ridge	Tognazzini	Tog 3	Well	Monterey		8925.50	27.42
F5h	3/26/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		8903.00	
E12	8/30/1983	8301414	Gato Ridge	Tognazzini	Tog 348C	Well	Monterey		8891.10	23.81
1	9/6/2016	8301414	Gato Ridge	Tognazinni	348C	Well	Monterey		8800.00	14.00
E55	8/30/1983	8301443	Gato Ridge	Tognazzini	Tog S3	Well	Monterey		8794.00	19.84
F5a	8/30/1983	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		8794.00	
E36	1/16/1984	8301412	Gato Ridge	Tognazzini	Tog 336	Well	Monterey		8714.20	47.40
E20	8/30/1983	8301400	Gato Ridge	Tognazzini	Tog 315	Well	Monterey		8657.50	27.70
E42	1/16/1984	8301400	Gato Ridge	Tognazzini	Tog 315	Well	Monterey		8645.90	54.85
E58	1/20/1984	8301452	Gato Ridge	Tognazzini	Tog 14	Well	Monterey		8554.90	19.98
F5e	2/3/1984	8301443	Gato Ridge	Magenheimer	TOG #3	Well	Monterey		8401.00	
E62	2/3/1984	8301443	Gato Ridge	Tognazzini	Tog S3	Well	Monterey		8400.60	39.96
E52	8/30/1983	8301408	Gato Ridge	Tognazzini	Tog 52	Well	Monterey		7951.00	15.95
E50	6/2/2011	8301403	Gato Ridge	Tognazzini	Tog 23	Well	Monterey		7800.00	8.95
F7	6/2/2011	8301404	Gato Ridge	Tognazzini	Tog 24	Well	Monterey		7800.00	32.00
E47	11/5/1976	8301455	Gato Ridge	Tognazzini	TOGNAZZINI #17 SWD	WD	Monterey		7630.43	
E69	8/30/1983	8301413	Gato Ridge	Tognazzini	Tog 337	Well	Monterey		7159.00	27.79
C8	11/29/2016	8301224	Gato Ridge	Magenheimer	A6	Well	Sisquoc	Thomas	21000.00	
B11b	5/5/1976	8301655	Gato Ridge	Tognazinni	Tog 43-A	WD	Monterey		11500.00	
B11a	7/16/1992	8301453	Gato Ridge	Tognazzini	Well 15 WW	WD	Monterey		8390.00	13.00
13	4/19/2015	8301414	Gato Ridge	Magenheimer	Tog #348C	Well	Monterey		8020.00	9.60
7	8/21/2015	8301383	Gato Ridge	Magenheimer	Mag #541	Well	Monterey		7500.00	
9	9/1/2015	8301436	Gato Ridge	Magenheimer	Mag #B-5 sect 4	Well	Monterey		7000.00	
8	9/1/2015	8301381	Gato Ridge	Magenheimer	Mag #511	Well	Monterey		7000.00	
B13e	3/31/1983		Gato Ridge	Magenheimer	Lease Water	Tank	??		6934.00	30.00
11	9/17/2015	8321724	Gato Ridge	Magenheimer	Mag #25	Well	Sisquoc/Monterey		6500.00	
12	9/17/2015	8301154	Gato Ridge	Magenheimer	Mag #A-5 sect 9	Well	Sisquoc/Monterey		6300.00	
B13c	1/9/1991		Gato Ridge	Petro Minerals	Magenheimer I	WW	??		6278.00	10.00
10	9/17/2015	8321595	Gato Ridge	Magenheimer	Mag #24	Well	Sisquoc/Monterey		6200.00	
B13a			Gato Ridge	Magenheimer Arata	Produced Water 1	Tank	??		3900.00	9.60

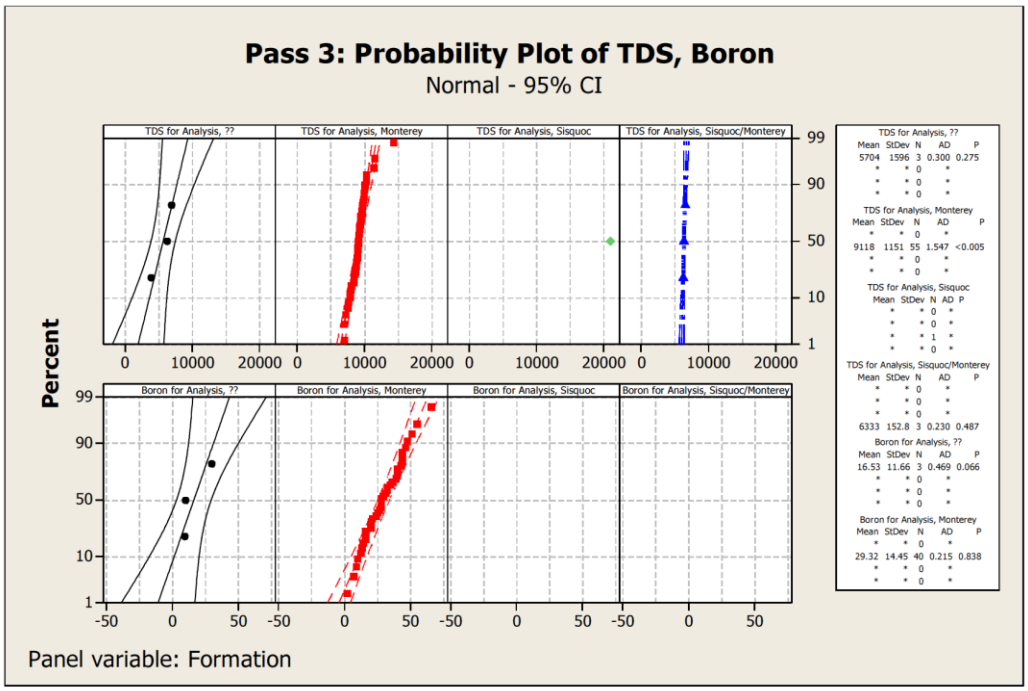

Figure 2.5-10

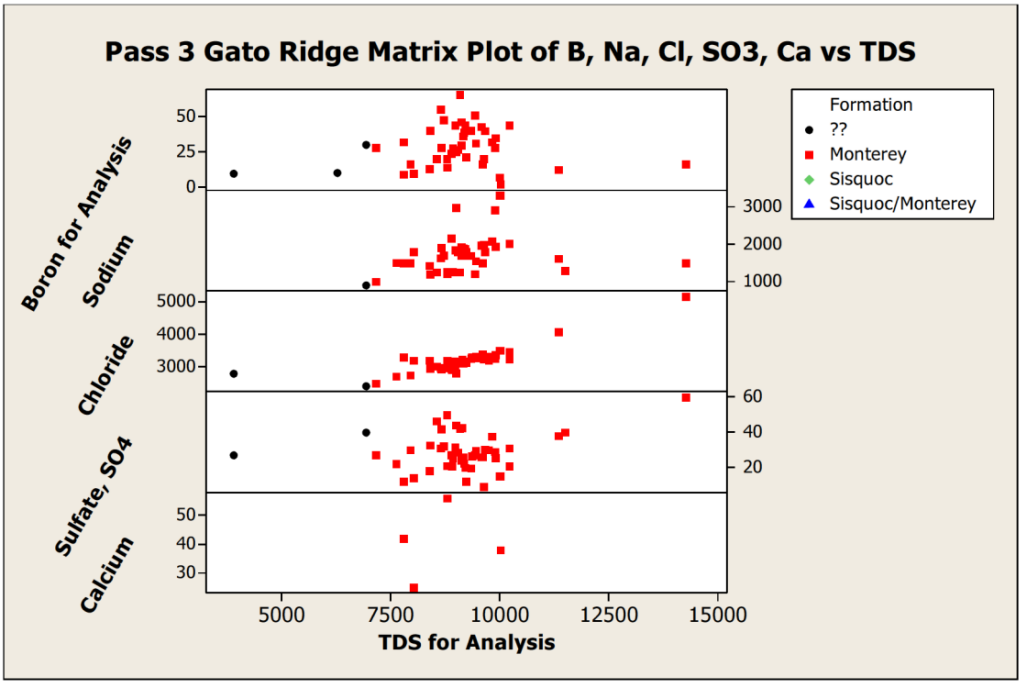

Figure 2.5-11

2.5.6 Final Reviewed Results

Table 2.5.6-1: Summary of Reviewed Data by Area and Formation(mg/L)

Area	Formation		TDS	B	Na	CL	SO4	HCO3	Ca	K	Mg
Sisquoc	Average Sisquoc	Mean	9990	26	1151	3266	116	4680	110	47	214
		Std Dev.	8028	9	721	2812	218	5196	51	59	177
		Count	38	28	28	36	27	29	9	27	27
	Post Steaming Production	Mean	5862	26	961	1924	75	2209	104	41	247
		Std Dev.	2600	9	426	1200	46	1572	50	60	179
		Count	27	25	22	27	22	22	8	22	21
	Native Sisquoc Formation	Mean	19862	34	2311	7436	295	11004	113	71	91
		Std Dev.	7558	17	1612	2269	500	6143	67	46	113
		Count	12	4	7	10	5	8	2	6	7
	Monterey	Mean	10417	7	1153	3216	57	4657	82	26	98
		Std Dev.	6445	5	798	1828	51	2395	73	23	82
		Count	14	14	14	14	14	14	6	14	12
Central	Sisquoc	Mean	10745	28	1641	4001	47	5539	29	36	21
		Std Dev.	3815	20	801	1420	22	2496	8	24	17
		Count	14	11	11	11	11	11	4	11	8
	Monterey	Mean	12314	19	1188	4033	67	5109	44	41	56
		Std Dev.	6823	22	454	1958	87	2221	7	68	37
		Count	17	7	16	16	17	17	5	16	15
East	Monterey	Mean	10417	7	1153	3216	57	4657	82	26	98
		Std Dev.	6445	5	798	1828	51	2395	73	23	82
		Count	14	14	14	14	14	14	6	14	12
	Sisquoc	Mean	7668	12	1263	2740	27	3528	41	16	75
		Std Dev.	2547	12	768	1019	20	1806	12	11	51
		Count	17	9	14	14	14	14	2	13	13
West	Monterey	Mean	12314	19	1188	4033	67	5109	44	41	56
		Std Dev.	6823	22	454	1958	87	2221	7	68	37
		Count	17	7	16	16	17	17	5	16	15
	Sisquoc	Mean	22007	42	876	8063	147	12252	15	50	49
		Std Dev.	5280	29	442	2096	103	3700		28	94
		Count	9	5	8	8	8	8	1	8	5
Gato Ridge	Monterey	Mean	9118	29	1769	3207	29	4003	41	14	62
		Std Dev.	1151	14	528	367	11	698	11	10	74
		Count	55	40	42	51	52	42	5	40	34
	Sisquoc	Mean	21000								
		Std Dev.									
		Count	1								
	Sisquoc/ Monterey	Mean	6333								
		Std Dev.	153								
		Count	3								

Appendices